march, 1961

nlgi spokesman

journal of the national lubricating grease institute

A Rheological Equation for Lubricating Greases
By E. O. FORSTER

What's Ahead in Farm Machinery Lubrication
By W. A. MAGIE, JR.

NLGI SPOKESMAN Index
VOLUME XXIV, APRIL, 1960—MARCH, 1961

GREASE MARKETERS . . . WILL YOUR BRAND NAME BE YEARS AHEAD FOR YEARS TO COME?

The oil constituents in greases are carefully controlled. Here chemist determines oxidation resistance of oil samples used in grease manufacture.

The years ahead represent a giant challenge to the best efforts of American industry. The answer lies in research by men with a driving scientific curiosity, working with testing equipment engineered to cope with stringent performance specifications.

To step up its research facilities, International Lubricant has recently completed a great new Research Laboratory. Here, highly trained chemists and engineers, cooperating with farsighted grease marketers, have rededicated themselves to work with untiring zeal so that no nation anywhere can surpass our efforts or our products in the field of lubrication. We invite your inquiry.

Specially developed analytical procedures are used to test the quality of lubricating oils from which International greases are produced.

INTERNATIONAL LUBRICATION

INTERNATIONAL LUBRICANT CORP.

NEW ORLEANS, LOUISIANA

Manufacturers of top quality lubricants: Aviation • Industrial • Automotive • Marine

With Research Comes Quality, With Quality Comes Leadership

nlgi spokesman

Volume XXIV March, 1961 Number 12

Published Monthly by the National Lubricating Grease Institute, T. W. H. MILLER, Editor; VIRGINIA ALLEN, Assistant Editor, 4638 J. C. Nichols Parkway, Kansas City 12, Missouri. Telephone VAlentine 1-6771. 1 Year Subscription, $5.00. 1 Year Subscription (Foreign), $6.00.

OFFICERS

President: F. R. HART, Standard Oil Co. of California, 225 Bush Street, San Francisco, Calif.

Vice-President: C. L. JOHNSON, Jesco Lubricants Co., P. O. Box 7331, North Kansas City, Mo.

Secretary: T. F. SHAFFER, Shell Oil Co., 50 West 50th Street, New York 20, N. Y.

Treasurer: A. J. DANIEL, Battenfeld Grease and Oil Corp., Inc., 3148 Roanoke Road, Kansas City 11, Mo.

DIRECTORS

W. W. ALBRIGHT, American Oil Co., 910 S. Michigan, Chicago, Ill.

T. W. BINFORD, D-A Lubricant Co., Inc., 29th St. and Canal, Indianapolis 23, Ind.

E. W. CAMPBELL, Gulf Oil Corp., P. O. Box 2140, Houston, Texas

J. J. COATES, Esso Standard Div., Humble Oil & Refining Co., 34th and Smallman St., Pittsburgh 1, Pa.

R. CUBICCIOTTI, Witco Chemical Co., Inc., 122 E. 42nd St., New York 17, N. Y.

H. B. ELLIOTT, Atlantic Refining Co., 260 S. Broad St., Philadelphia 1, Pa.

J. W. LANE, Socony Mobil Oil Co., Inc., 150 E. 42nd St., New York 17, N. Y.

W. A. MAGIE, II, Magie Brothers Oil Co., 9101 Fullerton Avenue, Franklin Park, Ill.

H. A. MAYOR, JR., Southwest Grease & Oil Co., Inc., 220 W. Waterman, Wichita, Kans.

G. E. MERKLE, Fiske Brothers Refining Co., 129 Lockwood Ave., Newark 5, N. J.

F. W. MINOR, Sinclair Refining Co., 600 Fifth Avenue, New York 20, N. Y.

W. M. MURRAY, Kerr-McGee Oil Industries, Inc., Kerr-McGee Bldg., Okla. City, Okla.

G. A. OLSEN, Sunland Refining Corp., P. O. Box 1512, Fresno, Calif.

F. E. ROSENSTIEHL, Texaco, Inc., 135 East 42nd Street, New York 17, N. Y.

W. H. SAUNDERS, JR., International Lubricant Corp., Box 390, New Orleans, La.

N. D. WILLIAMS, The Pure Oil Co., 200 E. Golf Road, Palatine, Ill.

Technical Committee Chairman: L. C. BRUNSTRUM, American Oil Co., Whiting Research Laboratory, Box 431, Whiting, Ind.

General Manager: T. W. H. MILLER, NLGI, 4638 J. C. Nichols Parkway, Kansas City 12, Mo., VAlentine 1-6771

IN THIS ISSUE

President's Page 454

Future Meetings 456

News About NLGI 458

A Rheological Equation for Lubricating Greases 462

E. O. Forster, Esso Research and Engineering Co.

What's Ahead in Farm Machinery Lubrication 466

W. A. Magie, Jr., Magie Bros. Oil Co.

NLGI Spokesman Index 472

Volume XXIV, April, 1960-March, 1961

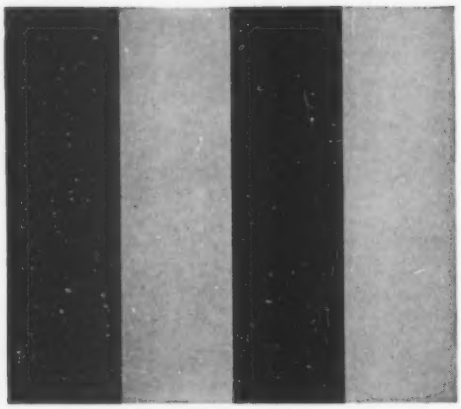
Literature and Patent Abstracts 476

Industry News 483

THE COVER

MECHANIZATION of the American farm is an old story to all of us . . . a development which began many years ago. What is often overlooked in these times is that the revolution has continued and the agricultural machinery continues to get bigger, better, faster and more productive, with each succeeding year. This John Deere row crop tractor, grain drilling with two drills hooked in tandem, is a case in point. But the continued development of this trend will partly depend on lubrication, believes the author of this month's article, "What's Ahead in Farm Machinery Lubrication" on page 466.

The NLGI SPOKESMAN is indexed by Industrial Arts Index and Chemical Abstracts. Microfilm copies are available through University Microfilm, Ann Arbor, Mich. The NLGI assumes no responsibility for the statements and opinions advanced by contributors to its publications. Views expressed in the editorials are those of the editors and do not necessarily represent the official position of the NLGI. Copyright 1961. National Lubricating Grease Institute.



NLGI PRESIDENT'S PAGE

By F. R. HART, *President*

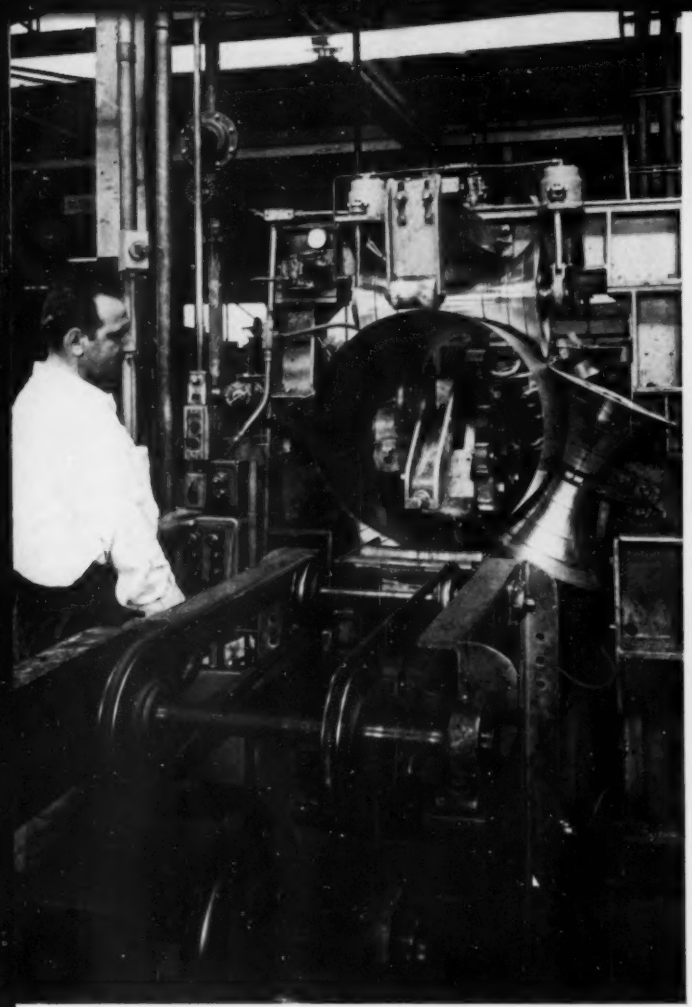
Centralized Lubrication Systems

Recently I received letters from two different manufacturers of lubrication equipment. One described an improved method of measuring pumpability; the other told of the savings accomplished through the use of modern application equipment. The messages in these letters are related and are mighty important to the future of the lubricating grease industry. We welcome more letters of this type from the manufacturers of lubrication equipment.

Those of us concerned with the application of lubricating grease know about the creative research work being done by equipment engineers. We think the resultant improved applicators are sorely needed to answer the demand for new and better ways of lubricating complicated machinery. The better the job done in solving application problems, the more certain will be the future need for lubricating grease. We wish to encourage this research work and to urge the early release of new developments. Certainly we will need different lubricators than those now available to take care of the new lubricants and machinery that will be available during the next ten years.

Centralized lubrication systems have proven to be a most efficient method of applying grease to machine bearings. Many large industrial accounts recognize the benefits of centralized lubricators and are installing them to reduce labor and material costs. While these conversions are beneficial, it is still necessary to "sell" some machine manufacturers on the importance of installing positive type lubricators on new devices. Here again, we lubricating grease people can be of great assistance in promoting the use of mechanical lubricators in the construction of all new equipment.

Lubricating grease is only useful when correctly applied to a bearing. Some person or some instrument is needed to remove the lubricating grease from the refinery fill package and introduce it to the bearing. The best, cleanest and cheapest way to do this job is to do it automatically—through a mechanical lubricator. Let's encourage equipment manufacturers and our customers to install more mechanical lubricators for correct lubrication.



10:00 a. m. *Order received and processed—steel begins to move, is formed into cylinder, feeds into automatic welder. Next—fabrication of lids, bottoms; then painting, drying, inspection.*

10:58 a. m. *Full tractor trailer load—200 standard 55-gallon drums—can be completed in less than one hour from receipt of order. When essential, this rush service is available to you.*

1/1000

Perhaps once in a thousand orders you *really* need rush delivery of drums. And from J&L you can get it.

For example, not long ago a large oil company had an emergency call from a good customer. In less than an hour, their nearest J&L plant produced 200 standard 55-gallon drums; fabricated, painted, dried, and loaded onto a tractor trailer, ready for fast delivery.

In an emergency, J&L can offer you rush service, too. Normal delivery is more than adequate for most situations. But when the situation is *really urgent*, we're glad to cooperate. There are *nine* J&L container plants spotted around the country. All are near major trucking and rail centers. All are prepared to offer you fast, dependable service on the complete J&L line of quality steel drums and pails.

For the whole story on J&L's complete line of standard and lined drums and pails, write for *free* booklet today!

Steel

J&L STEEL

Jones & Laughlin Steel Corporation

CONTAINER DIVISION • 3 GATEWAY CENTER • PITTSBURGH 30, PENNSYLVANIA

ATLANTA 1, GEORGIA
1280 Chattahoochee Avenue, N.W.
P. O. Box 1452—SY 4-8251

BAYONNE, NEW JERSEY
Constable Hook Road
P. O. Box 107—HE 6-9100

CLEVELAND 5, OHIO
8806 Crane Avenue
MI 1-2000

KANSAS CITY 15, KANSAS
Funston & Chrysler Roads
FA 1-1212

LANCASTER, PENNSYLVANIA
Manheim Pike and Steel Way
EX 4-4091

NEW ORLEANS 21, LOUISIANA
P. O. Box 10056, Jefferson Branch
5008 Jefferson Highway—VE 3-6352

PHILADELPHIA 37, PENNSYLVANIA
3711 Sepviva Street
JE 5-3100

PORT ARTHUR, TEXAS
Sabine Highway, P. O. Box 31
YU 5-5567

TOLEDO 1, OHIO, City Park and Hamilton Street, CH 1-6241

Future Meetings

APRIL, 1961

11-13 American Society of Lubrication Engineers Annual Meeting and Exhibit, Bellevue - Stratford Hotel, Philadelphia.

19-20 National Petroleum Association, Semiannual Meeting, Sheraton-Cleveland Hotel, Cleveland.

MAY, 1961

8-9 ASME Lubrication Symposium, Deauville Hotel, Miami Beach, Fla.

13 NLGI Board of Directors meeting, site undecided.

15-16 Lubrication Committee of API, The Diplomat, Hollywood Beach, Fla.

16-19 API Division of Marketing, Midyear Meeting, Americana Hotel, Miami Beach.

JUNE, 1961

11-15 ASME Summer Annual Meeting, Statler Hilton Hotel, Los Angeles.

24-29 ASTM Committee D-2 meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

SEPTEMBER, 1961

11 NLGI Board of Directors meeting, Roosevelt Hotel, New York City.

13 API Division of Marketing, Lubrication Committee Meeting, Traymore Hotel, Atlantic City, N. J.

13-15 National Petroleum Association, Annual Meeting, Traymore Hotel, Atlantic City.

24-26 Independent Oil Compounders Association, Annual Meeting, Villa Moderne Motor Hotel, Highland Park, Ill.

24-28 ASTM Committee D-2 meeting, Statler Hotel, Detroit.

OCTOBER, 1961

17-19 ASME-ASLE Lubrication Conference, Hotel Morrison, Chicago.

OCT. 29 - NOV. 1, 1961 NLGI Annual Meeting, Rice Hotel, Houston, Tex.

NOVEMBER, 1961

9-10 SAE National Fuels and Lubricants Meeting, headquarters undecided, Houston, Tex.

13-15 American Petroleum Institute Annual Meeting, Conrad Hilton Hotel, Chicago.

26-Dec. 1 ASME Winter Annual Meeting, Statler Hilton Hotel, New York.

HARSHAW LEAD BASE

Harshaw Lead Base, as an additive to petroleum lubricants, improves extreme pressure characteristics and imparts the following desirable properties:

- Increased film strength
- Increased lubricity
- Improved wetting of metal surfaces
- A strong bond between lubricant and metal surfaces
- Resistance to welding of metals at high temperatures
- Moisture resistance and inhibits corrosion

Harshaw Lead Bases are offered in three concentrations to suit your particular needs:

Liquid	Liquid	Solid
30% Pb	33% Pb	36% Pb

Other metallic soaps made to your specifications. Our Technical Staffs are available to help you adapt these products to your specific needs.

THE HARSHAW CHEMICAL CO.
1945 E. 97th Street • Cleveland 6, Ohio
Branches In Principal Cities

DEEP ROCK
Superior Specifications

CYLINDER STOCKS
Fine Lubricating Qualities For Greases and Fluid Lubricants
Kerr-McGee Oil Industries, Inc.
Kerr-McGee Building
Oklahoma City, Okla.
CE 6-1313

QUALITY LUBRICANTS

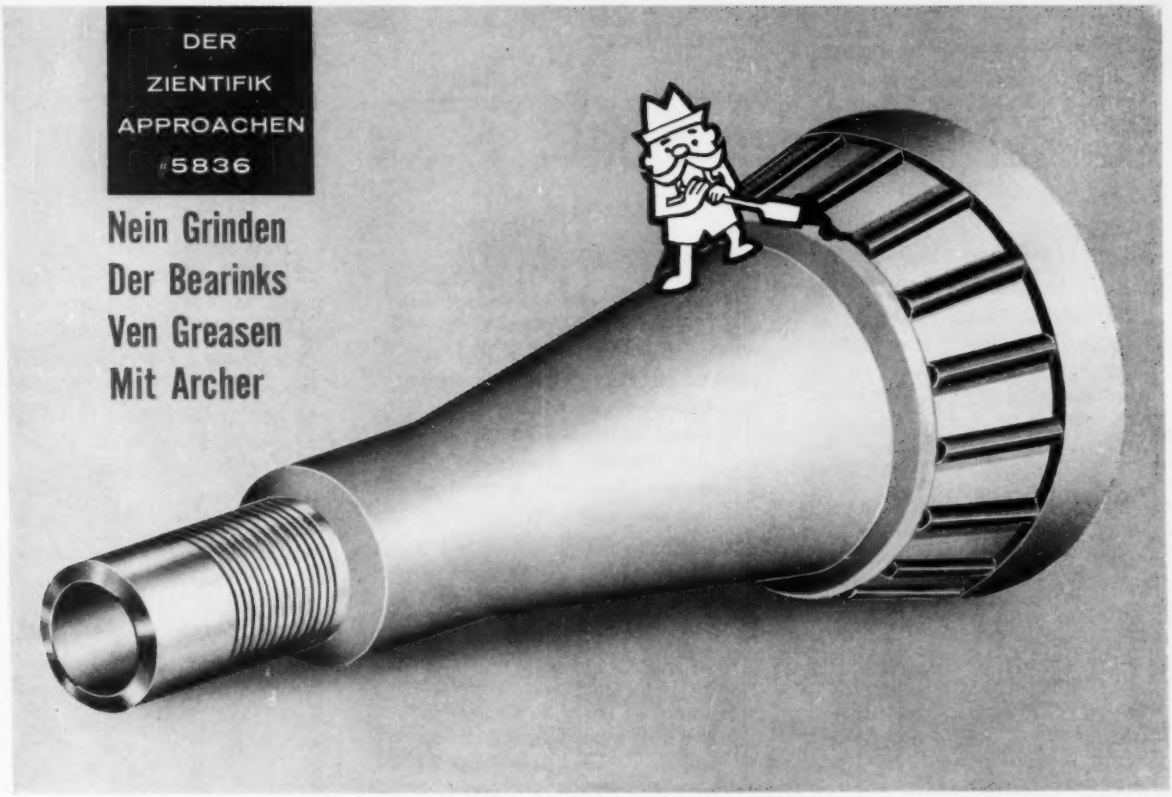
INDUSTRIAL
AND
AUTOMOTIVE

Manufactured for

REFINERS
COMPOUNDERS
JOBBERS

FISKE BROTHERS REFINING CO.

PLANTS
Newark, N. J. Toledo, Ohio



Hydrofol Acid 51 ist Bearen der Wearen

Upstanden unter stressen! Greases made with Archer's grease grade Acid 51 have toughness that stands up under stress. They inherit it from the arachidic and behenic acids this hydrogenated marine oil acid carries. These long chain acids (C_{20} and C_{22}) also tend to keep grease from separating under prolonged punishment.

But das ist not alles! Hydrofol Acid 51 means versatility in any language. With arachidic and behenic acids, it combines fatty acids with chain lengths starting at C_{14}. The result is a base ideal for greases that must lubricate efficiently under a broad range of mechanical and environmental conditions ... mit out wearink der bearinks. Extreme pressures. High temperatures. Contaminants. Shock loads. Shearing and squeezing actions. Especially recommended for automotive wheel bearings and industrial machinery bearings.

AXIOM: Ven Shooten for der Toppen, to Archer der Order Given.

Hydrofol Acid 51 is readily soluble in petroleum oils and most solvents. It resists oxidation and contains no polyunsaturated acids. Unt it's so economik! Its versatility lets you simplify your raw materials inventory, and thereby cut expenses.

Vant der zientifik scoopen? Den writen soonish to unter addressen. Technical data and research samples will be sent to you.

SPECIFICATIONS

Titer	51-53°C
Acid Value	197-202
Iodine Value	6 max.
Calculated Molecular Weight	277-284
Color 5¼" Lavibond	25Y/2.5R max.

Archer-Daniels-Midland

INDUSTRIAL CHEMICALS DIVISION
741 Investors Bldg., Minneapolis 2, Minn.

Chemifats from Nature's Wondrous Warehouse

News About NLGI

Three New Member Firms Join NLGI

Southline Metal Products, of Houston, a container manufacturer, has joined the Institute as an Associate member. W. F. Wackman, vice-president, will act as Company representative to NLGI, and J. W. Wood, salesman, will be the Technical representative.

Axel Christiernsson, of Stockholm, Sweden, a manufacturer of lubricating greases, has affiliated as an Active member. The Company representative will be H. Heinerwall, director, while the Technical representative will be L. Abelin, engineer. Axel Christiernsson makes the twentieth overseas firm with affiliation in the Institute.

Thatcher Glass Mfg. Co., of Nashua, New Hampshire, a manufacturer of containers, was also accepted for membership last month. Henry E. Griffith, vice-president, is Company representative, while George H. Holoubek will serve as Technical representative.

Ambler Resigns From Board of Directors

S. C. M. Ambler, product line coordinator of the British American Oil company, Toronto, Ontario, Canada, has announced his resigna-

S. C. M. Ambler

Continued on page 482

SERVICE AIDS

Send Orders to: National Lubricating Grease Institute, 4638 Nichols Pkwy., Kansas City 12, Mo.

NLGI GLOSSARY—A four-page booklet containing definitions of terms relating to the lubricating grease industry. Usable by marketing as well as technical people. Fifteen cents per copy (NLGI member price) and twenty-five cents (non-member).

REPRINTS — From the NLGI SPOKESMAN are available at low cost. Page forms are left standing for three months, company imprint or advertising arranged.

NLGI MOVIE — "Grease, the Magic Film," a 16-mm sound movie in color running about 25 minutes, now released. First print $300, second and subsequent orders $200 each (non-members add $100 to each price bracket).

LINCOLN MOVIE — "You—the Jury," a 16-mm sound movie in color, 18 minutes, telling the application story in the lube bay. May be reserved without charge from NLGI. A gift of Lincoln Engineering Co.

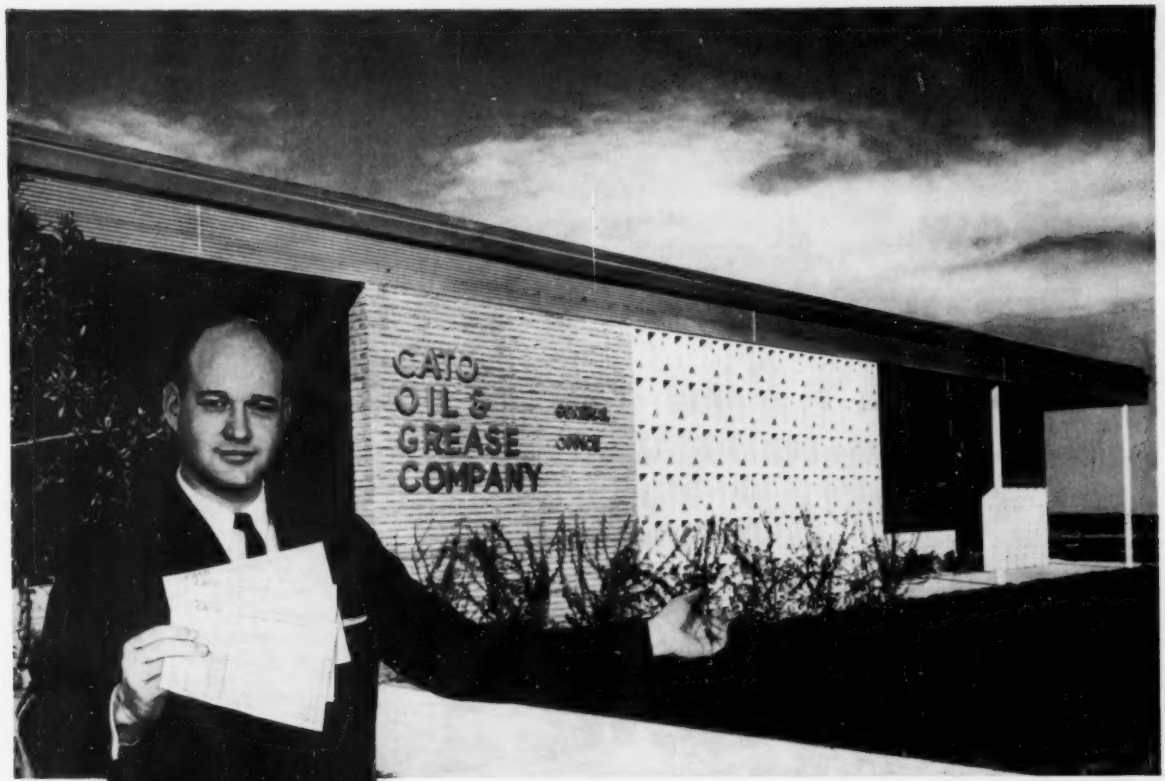
CATO MOVIE — "Lessons to be Learned from the Cato Grease Plant Fire." A 16-mm sound movie, 26 minutes, depicting how to avoid a fire in a lubricating grease manufacturing plant with step-by-step procedures.

VOLUME XXI—Bound volume of the NLGI SPOKESMAN from April, 1957 through March, 1958. Contains 34 articles and features dealing with lubricating greases and gear lubricants . . . $7.50 (NLGI member price) and $10.50 (non-member) plus postage.

VOLUME XXII—Bound Volume of the NLGI SPOKESMAN from April, 1958, through March, 1959. Contains 31 articles and features dealing with lubricating greases and gear lubricants . . . $7.50 (NLGI member price) and $10.50 (non-member) plus postage.

VOLUME XXIII—Bound Volume of the NLGI SPOKESMAN from April, 1959 through March, 1960. Contains 36 features on every phase of the lubricating and fluid gear lubricants industries . . . $7.50 (NLGI member price) and $10.50 (non-member) plus postage.

WHEEL BEARING MANUAL — "Recommended Practices for Lubricating Automotive Front Wheel Bearings." More than 170,000 copies of this booklet have been distributed throughout the world. Now in its sixth printing. Sixteen pages, with more than 40 illustrations. Twenty-five cents a copy, with quantity discounts — company imprint arranged.



YOUR ORDERS DESIGNED OUR OFFICE!

Our new office building and all of the modern equipment in it was designed with one major purpose in mind—processing your orders quickly and efficiently.

Our highly trained staff has only one objective , that of giving you, our customer, the ultimate in accuracy and prompt service. This goal has been achieved through the use of modern data processing equipment.

We appreciate your orders, since they are the foundation of our business. May we have the privilege of serving you.

Ralph Jenks
Secretary-Treasurer

CATO OIL AND GREASE COMPANY

Oklahoma City, Oklahoma

Now Available...

Foil Seals of NLGI'S NEW PROMOTION CHARACTER

New Registered Figure Designed for Maximum Utility In Advertising, Sales Promotion, Public Relations

YOU MAY PUT him to work for you immediately. This little man is the result of a great deal of work by the Institute's Chassis Lubrication Committee. He was introduced in February and a contest is under way to give him a name. In the meantime, member firms may obtain free artwork in black and white as shown above, or in three colors—red, blue and black on white . . . by writing the national office. The little man may be purchased on aluminum foil stickers, too. He is in full color on seals which measure one by one-and-a-half inches, which add a distinctive touch to correspondence, advertising, etc. Foil seals are ten dollars for a box of one thousand, postage paid. Orders will be processed immediately.

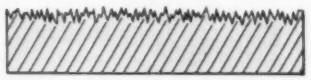
National Lubricating Grease Institute 4638 J. C. Nichols Parkway, Kansas City 12, Missouri

CLIMAX MOLYBDENUM

Molysulfide® News Digest

CLIMAX MOLYBDENUM COMPANY, a division of American Metal Climax, Inc., 1270 Avenue of the Americas, New York 20, N.Y.

MOLYSULFIDE INCREASES TOOL LIFE AS MUCH AS 300 PER CENT



When magnified, a piece of highly polished metal is actually smooth to touch, yet presents a cross-section of saw-tooth irregularity. Molysulfide fills in the valleys, prevents the peaks from tearing, permits plastic deformation of the metal to make a smoother surface.

COMPOUND CONTAINING MOLYSULFIDE REDUCES MACHINERY WEAR-IN TIME

During the wear-in period of machinery, permanent surface damage . . . variously described as *galling, scuffing, scoring, tearing, scratching, excessive abrasion* and *seizing* . . . is an inherent hazard.

After years of experience, leading equipment builders agree that an MoS_2 compound is the best guarantee against wear-in damage. Here are five ways such a compound, applied to moving parts prior to operation, can save you wear-in time, money and possible grief:

1. Shortens wear-in period without use of abrasives.
2. Eliminates stick-slip behavior and resists galling and seizing at bearing pressures far beyond the yield point of any metals.
3. MoS_2 particles have a tenacious adherence to bearing surfaces. Will not scrape off.
4. Need not be burnished into surface. Brush or wipe on a thin coating.
5. Inexpensive in the long run. A little goes a long way.

When writing, refer to CL-103

MoS_2 Provides Greater Resistance to Wear at High Temperatures

The Alpha-Molykote Corporation in Stamford, Conn., is now marketing a new Molysulfide bonded lubricant for ferrous surfaces.

Applied with a conventional paint spray gun, this compound fills the microscopic valleys of the surfaces of tool steel and gives on-the-spot lubrication that allows the chips to glide. Once sprayed, it dries at room temperature to a tough film that has a thickness of 0.0001—0.0008 in. and a coefficient of friction of 0.03 at 100,000 psi.

Extremely resistant to wear at high pressures and temperatures (operating temperature range -300 to 600 F) this new compound requires neither chemical nor mechanical surface pretreatment and, because of its high adherence and low friction coefficient, it increases cutting tool life as much as 300%.

Effectiveness of this lubricant comes mainly from the weak layer-to-layer bonds which allow easy sliding and, within individual layers, from the cohesive forces between Mo and S atoms that are quite strong and prevent penetration by surface asperities.

Minimum coverage coating is 285 sq. ft./lb., and consumption is about 1% of tool weight. Normal lubricating oils, cutting fluids or solvents have no effect on these coatings.

When writing, refer to CL-101

Punch Life Increased from 2,000 to 25,000 Holes in Steel Plate

These punches (11/16") were used to punch 25,000 holes in ½"—1020 cold rolled steel plate. Without a lubricant containing MoS_2, a maximum life of only 2,000 holes could be obtained.

A West Coast manufacturer was experiencing low punch life with the best available lubricants. His multiple punching operation consisted of cold shearing 50 holes simultaneously in a single steel plate. A maximum life of 2,000 holes per punch was obtained with ordinary lubricants.

Then, a compound containing Molysulfide was applied to the punch. The result: punch life was increased from 2,000 to 25,000 holes and, as can well be imagined, considerable savings were effected.

When writing, refer to CL-102

A Rheological Equation For Lubricating Greases

By: E. O. Forster
Esso Research and Engineering Co.

Presented at the NLGI 28th annual meeting in Chicago, October, 1960

I. Introduction

Greases are characterized by their ability to resist flow up to a certain finite stress. Once this yield stress has been exceeded, the grease will start to flow and its viscosity will decrease, since it is a function of the shear stress. (Thus at stresses smaller than the yield stress, greases will have for all practical purposes an infinitely large viscosity.) The dependence of a grease's viscosity on shear stress must be known over a wide range in order to predict its behavior in such applications as bearing lubrication and flow through pipes. Many flow equations have been deduced[1, 2, 3, 4, 5, 6, 7] from results obtained over various shearing conditions. Some of these equations include the yield stress[4, 5, 6] while others include the ultimate viscosity[4] or the viscosity of the base oil.[3, 5] None of these equations permits a linear extrapolation of the viscosity to regions of very low or very high shear stresses. An equation for greases has now been derived from theoretical considerations which includes both the yield stress and the ultimate viscosity of the grease. With the help of this equation, it is possible to predict the flow of a grease both at very low as well as very high shearing stresses by linear extrapolation of data obtained in the intermediate range. In the following sections, the theoretical considerations are discussed in detail and this equation is applied to several grease systems to illustrate its applicability.

II. Theoretical Considerations

It is well known that greases can be visualized to be made up of a three dimensional fiber structure with the base oil trapped within the spaces between the fibers, much like water is trapped within the cavities of a sponge. But unlike the sponge, the fiber structure will rupture once a critical stress, the yield stress, has been applied. If a stress smaller than this yield stress is applied to the grease, it is still possible that some fracture will occur; but the reformation of the fiber junctions will be fast enough so that for all practical purposes, the grease will not be sheared although it might creep and it is assumed that under these conditions the shear rate is zero[8]. At very high shear stresses, the fiber structure will have been disrupted to such an extent that one can visualize the system to be essentially a dispersion of very small soap fibrils in the base oil. The viscosity of such a dispersion, the ultimate viscosity, can be predicted reasonably well by using a correction similar to that used by Criddle[4]

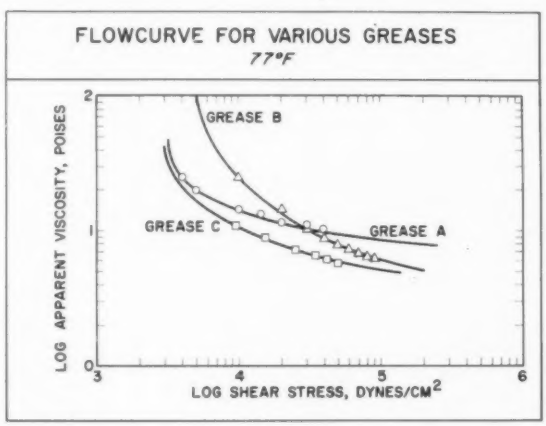


FIGURE 1.

which is based on the development by Guth and Simha[9]. The general relationship between shear stress and apparent viscosity can be visualized to follow a hyperbola the asymptotes of which are the yield stress on the vertical coordinate and the ultimate viscosity on the horizontal coordinate as shown in Figure 1. The only way greases will differ among themselves will be rate of decrease of the viscosity with shear stress and the location of the asymptotes. The decrease in viscosity with increasing shear stress reflects the breakdown of the soap fiber structure. A rapid drop in apparent viscosity will obviously mean a rapid breakdown of the soap structure and hence indicate poor adhesion between contacting soap fibers. It should be possible, therefore, to characterize the strength of each type of soap fiber network by an exponential parameter since it represents the probability of the breaking of contact points and such probabilities follow exponential laws. Indeed, such exponential relationships have been used on an empirical basis by several investigators[5,6,10] but the physical significance of these exponents had not been recognized previously. On the basis of this reasoning, it follows that this exponent should have a characteristic value for each grease type. The effect of soap content, of degree of dispersion and hence the method of manufacture should then be represented by changes in the curvature of the hyperbola as reflected in the value of the parameter K which controls this curvature. Thus a series of greases made from the same base oil and the same soap system but with increasing soap content would be characterized by increasing values of K while the exponential parameter should remain the same. The mathematical expression satisfying these requirements has the following form:

$$(\tau - \tau_o)^n (\eta - \eta_\infty) = K$$

where τ_o is the yield stress, τ is any shear stress, η_∞ the ultimate viscosity, η any apparent viscosity, n and K the parameters mentioned earlier.

If one transforms this equation into its logarithmic form, one obtains

$$n \log (\tau - \tau_o) + \log (\eta - \eta_\infty) = \log K$$

which is the expression for a straight line with slope n and intercept log K. This linear relationship thus lends itself to extrapolation to extreme values knowing only

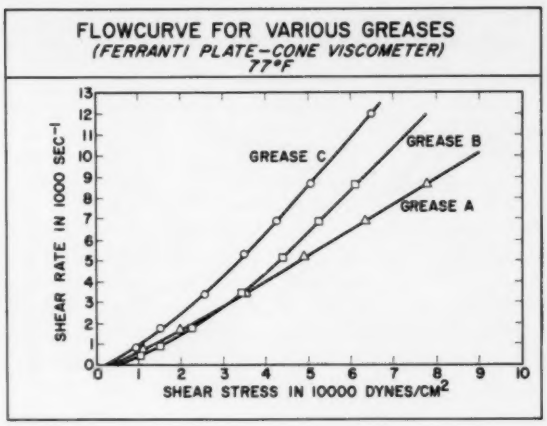


FIGURE 2.

points in the intermediate range. This is a distinct advantage since it is rather difficult, if not impossible, to obtain experimental data points at either end of the flow curve.

III. Evaluation of n and K

The general procedure used in determining n and K involves the following steps.

(a) A plot of nominal shear rate (sec^{-1}) versus the shear stress ($dynes/cm^2$) is made from the data obtained by means of a viscometer such as a capillary or plate-cone viscometer as shown in Figure 2. From such a plot the value of τ_o can be deduced by extrapolating the curves to zero shear rate if this value has not been obtained from direct observation.

(b) Next, the apparent viscosity (shear stress/nominal shear rate) is calculated from the data used in (a) and plotted as a function of shear stress, giving a plot similar to that already shown in Figure 1 (for convenience, such plots are usually made on log-log paper). This plot can be extrapolated to high shear stresses to obtain a rough estimate of the ultimate viscosity. If sufficient data are available, similar extrapolation can be made from the plot shown in Figure 2 if one assumes that the flow curve will become linear at high shear stresses. In those cases, where

About the Author

E. O. Forster *received his BS and a PhD degree in physical chemistry from Columbia university in* 1949 *and* 1951, *respectively. Since then he has been engaged in lubrication research with Esso Research & Engineering Co., where he is presently a research associate in the central basic research laboratory. A member of ASLE, ASME, ACS and the Society of Rheology, Dr. Forster received the Alfred E. Hunt memorial medal from ASLE last year. Author of numerous articles in the field of greases and lubrication, he holds ten U. S. patents in the field of lubrication. A former member of NLGI's Fundamental Research subcommittee, he has contributed to the* Spokesman *before.*

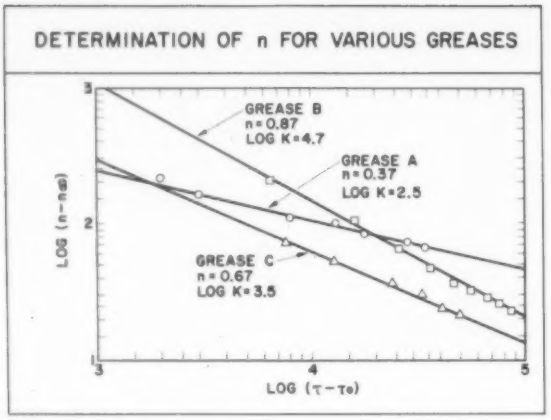


FIGURE 3.

sufficient information on the base oil viscosity and soap concentration is available, it is possible to calculate the approximate ultimate viscosity as indicated earlier from the equation[4,9]

$$\eta_\infty = \eta_0 (1 + 2.5v + 14.0v^2)$$

where v is the volume fraction of the thickener used in making this grease. Since this equation does not take into consideration the length to diameter ratio of the soap particles (it was originally derived for spheres) and the effect of water, like in the case of lime soap greases, the results so obtained can only be considered as first order approximations.

(c) Knowing the yield stress and ultimate viscosity, it is possible to make a plot of log $(\tau - \tau_0)$ against log $(\eta - \eta_\infty)$ as shown in Figure 3. From this plot the slope n of the straight line can be determined. Once n is known, the value of K can be obtained by substitution into the equation. If high precision is desired, the last two operations mentioned have to be performed by a least squares analyses.

Using the procedure outlined above, three types of calcium soap greases were analyzed. The results are shown in Figures 1, 2 and 3 and are summarized in Table I.

TABLE I

Composition and Flow Data for Calcium Soap Greases

Grease:	*A*	*B*	*C*
Composition			
Soap Type	Calcium	Calcium/ Lithium	Complex Calcium
Soap Content, % by weight	10	12	20
Base Oil Viscosity SUS, at 100°F.	330	650	529
NLGI Grade	0	2	1
*Flow Data**			
Yield Stress, τ_0 (dynes/cm²)	2000	3500	2000
η_∞, poises	3.5	4.0	3.7
n	0.37	0.87	0.67
log K	2.5	4.7	3.5

**Obtained with the Ferranti-Shirley plate-cone viscometer.*

It can readily be seen that n has different values for the three types of greases and reflects the difference in the soap structure. The values of K cannot be compared directly since each grease has a different n.

To test the concept of constant parameter n for greases containing different amounts of the same soap system, two sets of data were taken from Ref. 10. Since the data points had to be read off the graph, relatively poor precision was obtained resulting in a possible error in n of about ±10 per cent as contrasted to an error of about ±2 per cent in the cases shown in Table I. The results are shown in Figures 4 and 5 and are summarized in Table II.

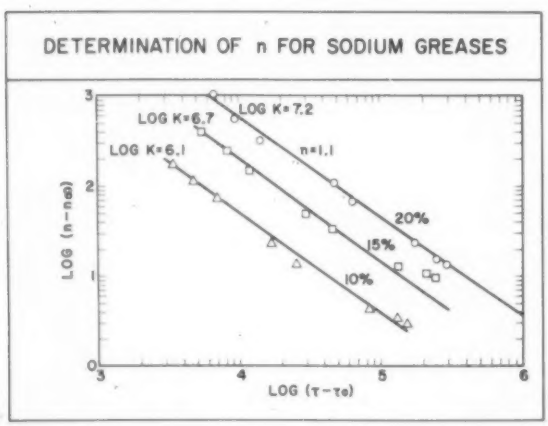


FIGURE 4.

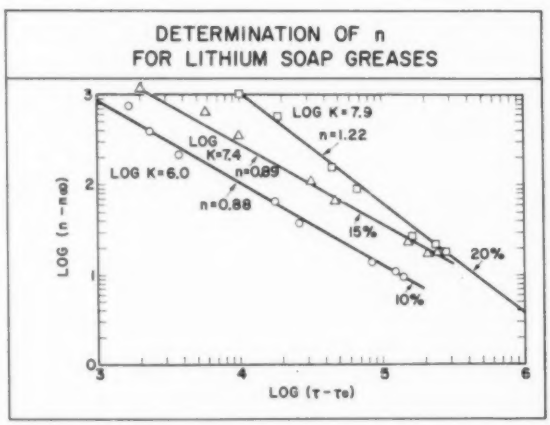


FIGURE 5.

TABLE II

Flow Data for Sodium and Lithium Soap Greases

	Sodium Soap Grease (in a 840 SUS/at 100°F. Mineral Oil)		
Concentration, % by weight	10	15	20
NLGI Grade	0	2	3
Yield Stress, τ_o, in dynes/cm^2[(1)]	1500	5000	20,000
η_∞, poises[(1)]	13	16	18
n	1.1	1.1	1.1
log K	6.1	6.7	7.2
	Lithium Soap Grease (in a 840 SUS/at 100°F. Mineral Oil)		
Concentration, % by weight	10	15	20
NLGI Grade	2	3	3
Yield Stress, τ_o, dynes/cm^2[(1)]	18,000	28,000	40,000
η_∞, poises[(1)]	6.65	10.0	13.2
n	0.88	0.89	1.22
log K	6.0	7.4	7.9

[(1)] *Extrapolated*

From these data it appears that n might be indeed a characteristic parameter of the soap type while K reflects the consistency of the grease although the 20 per cent lithium soap grease has for unknown reasons a different value for n.

IV. Discussion

Many flow equations have been developed[1,2,3,4,5,6] based, in most cases, on experimental results. Mahncke and Tabor[1] and Singleterry and Stone[2] concluded that greases behave like Bingham bodies, while Ree and Eyring[3] describe the flow in terms of the theory of rate processes. An empirical approach was followed by Criddle[4] who describes the flow of grease in terms of three factors: (A) the flow rate expected for the oil, (B) an Einstein correction term for the volume fraction thickener, and (C) a term determined by the yield stress and the shear breakdown. Sisko[5] derived a flow equation which describes the flow of greases in terms of Newtonian and non-Newtonian flow units. This development does not include the yield stress of the grease. Bauer[6] more recently advanced a modification of Sisko's equation in which he included the yield stress but did not explicitly include the ultimate viscosity. The new equation which has been derived from theoretical consideration includes both the yield stress and the ultimate viscosity and appears on the basis of the limited number of tests performed so far to represent the behavior of greases that do not show any further structure breakdown—in other words, the plot of shear stress against shear rate, like that shown in Figure 2, will exhibit no hysteresis loop. The error introduced by this assumption is believed to be rather small. The question whether this equation is also applicable to non-soap thickener greases has not been examined as yet. Thus far, the effects of temperature on the parameter n and K have not been considered.

When comparing this equation with those discussed previously,[1,2,3,4,5,6,7] it can be noted that it has the advantage of providing a means of linear extrapolation from an intermediate range of data points to extreme values of shear stress, which, in the past, has not been possible. While most previous equations related shear stress to shear rate, the new equation relates shear stress to apparent viscosity. This in itself is not an innovation, but the mathematical form achieved in this manner is believed to be more convenient to use and more adaptable for such calculations as are encountered in the lubrication theory of bearings and in the prediction of flow through pipes.

While previous equations[4,5,6] realized the exponential relationship of the shear stress, none have been able to give physical significance to these coefficients. The equation presented here, unlike the previous ones, did not attempt to fit a mathematical expression to experimental data points but rather started from some theoretical considerations and stipulated the physical significance of the parameters n and K. On the basis of the experimental evidence available, it appears that this concept is correct. Further experimental work particularly at different temperatures will have to be performed to solidify this argument. It would also be necessary to establish the accuracy with which the values of n and K can be obtained from experimental determinations so as to determine their reliability.

The linear relationship between the log $(\tau - \tau_0)$ and log $(\eta - \eta_\infty)$ which has so far been found to be valid in the cases tested should be, if generally proven to be true, of great value in providing both the design and lubrication engineer with a rapid estimate of the flow characteristics of greases in bearings and pipes. With the help of this equation, it should also be possible to elucidate the relationship between soap structure of a grease and its flow characteristics.

References

1. Mahncke, H. E., and Tabor, W., *Lubrication Eng., 11,* 22 (1955).
2. Singleterry, C. R., and Stone, E. E., *J. Colloid Science, 6,* 171 (1951).
3. Ree, T., and Eyring, H., *J. Appl. Phys., 26,* 793, 800 (1955).
4. Criddle, D. W., "A New Equation for Calculating Flow of Lubricating Greases," NLGI Spokesman, *22,* 381 (Nov. 1958).
5. Sisko, A. W., *Ind. and Eng. Chem., 50,* 1789 (1958).
6. Bauer, W. A., Finkelstein, A. P., and Wiberley, S. E., "Flow Properties of Lithium Stearate-Oil Model Greases as Functions of Soap Concentration and Temperature," Paper No. 59-AM2B1, ASLE Annual Meeting, Buffalo (1959).
7. Metzner, A. B., *Advances in Chemical Engineering,* Vol. 1, Chap. 2, Academic Press, N. Y. (1956).
8. Forster, E. O. and Kolfenbach, J. J., *Trans. ASLE, 2,* No. 1 13, (1959).
9. Guth, E., and Simha, R. J., *Kolloid Zeit., 74,* 266 (1936).
10. Tyabin, N. V., and Vinogradov, G. V., *Koll.Zh.* 19, 352-60, (1957).
11. Roehner, T. G., and Robinson, R. C., NLGI Spokesman, 10, No. 12, 4 (1947). ■

What's Ahead in Farm Machinery Lubrication

By: W. A. Magie, Jr.
Magie Bros. Oil Co.

Presented at the NLGI 28th annual meeting in Chicago, October, 1960

CONTINUED improvement and successful application of farm machinery will depend, at least in part, upon more cooperation between the farmer, equipment manufacturer and the lubricant manufacturer to simplify and standardize farm machinery lubrication. The author feels that a maximum of six lubricants should be recommended with a maximum of seven service intervals for *all* farm equipment. This standardization and simplification is a must for the future if we want the development of farm machinery to continue at its record pace.

The mechanization of the American farmer has progressed at a very rapid rate as can be seen by some figures released by the State-Federal Crop Reporting Service. Figures released on May 4, 1960 show that in Illinois alone almost 120,000 farms have switched from horses and mules to tractors in the period from 1920 to 1960.[1]

In 1910 there were 32 million people living on farms and the total United States population was 90 million. Today there are only 21 million people living on farms in the United States and the population has doubled or is 180 million. With a 35 per cent reduction in the number of people living on farms, they are now supporting twice the population of 1910. In other words, there is less than one person on the farm to support eight persons in the city.

It was not more than 15 years ago that it was common to see men pitching loose hay onto a hay rack which was drawn by a horse. Today with the new balers to assist the farmer, it is possible that from the time the hay is cut until it is in the barn it may never be lifted by the farmer. Also most men farming today can remember picking corn by hand and then later shelling it by hand. Today it is not uncommon to see self-propelled machines that will pick and shell from two to four rows of corn at one time. It would seem, then, that the farmer's problems are over when these modern machines can do so much.

However, mechanization has not brought an end to the problems associated with farming. First of all, the modern, mechanized farmer has found that his machines are capable of doing more work than he can do by himself. He needs men to help him haul the 4,000 bushels of corn, that he can pick in one ten-hour day, from the field to the barn. Today this extra help comes from hiring men rather than exchanging help, as was the practice a few years ago. Normally a farmer will hire a man for a period not exceeding six months. In this relatively short time the farmer may have to teach his hired man how to run the complicated machinery needed to plow, plant, cultivate and harvest his crops each year. This means that there is little time left to teach these men how to correctly maintain his equipment. Often a farmer will find that he does not have enough time to read an operator's

FARMING today is becoming more and more mechanized. Here a new tractor, equipped with both front and rear power take-offs, enables a farmer to use a front-mounted mower and rear-mounted pto-driven hay conditioner simultaneously.

manual of 50 to 100 pages, much less know the difference between motor oils, gear oils and greases. It is no wonder then that lubricants can be misapplied or not used at all due to the complexity of recommendations.

Anyone who has dealt with farm lubrication can give classic examples of errors in lubrication, so only two will be given here. One of these involved a large farmer in the rice country who bought some transmission grease and a chain plate lubricant in the spring. A few months later the salesman returned to find the chain plate lubricant gone and the transmission oil untouched. A quick check revealed the location of the chain plate lubricant—in the transmission of a tractor. The second case was where a midwest farmer sent his hired man to the shop to get some motor oil. The hired man returned with a five-gallon can marked "motor oil" and poured part of its contents into a tractor. A short time later the tractor stopped, and it was soon learned that the contents of the can were *not* motor oil but crop spray.

These costly errors are not uncommon and something has to be done to prevent their recurrence especially when each piece of machinery may cost the farmer from $5,000 to $20,000 or more. Each hired man may be running *one* piece of equipment that may be worth more than *all* the machinery a farmer had on his farm 25 years ago. The most logical solution to the problem of foolproof maintenance is a standardization of lubricants plus a simplification of recommendations as applied to farm equipment. Presently there are too many lubricants recommended, and also too many different service intervals. A look at present conditions plus a look at possible future trends may help us simplify lubrication and make future farm machinery more foolproof.

Presently all the lubricants used on a farm can be placed into four general groups: grease, transmission oil, hydraulic oil and motor oil. Within each of these groups there are many special lubricants, which are recommended for only *one* specific piece of machinery. It would seem to be possible to have fewer recommended lubricants so as to reduce the chance of misapplication. In order to back up this idea of fewer lubricants, let us take each one of the four groups individually and see what is happening and what can happen through more coordination between the machinery manufacturer and the lubricant manufacturer.

Greases

In Figure 1 it will be noted that there are five different greases recommended to properly service eight recently-made American diesel tractors. These five greases are: chassis grease, lithium grease, water pump grease, wheel bearing grease and graphite grease. One of these eight tractors requires four out of the five greases. It is possible that a farmer may own a com-

GREASES

Greases	*Tractors*							
	A	B	C	D	E	F	G	H
Chassis	X	X	X	X	X	X	X	X
Wheel Bearing	X	X	X	X	X	X		
Graphite		X						
Water Pump						X	X	
Lithium						X		X

FIGURE 1

bination of these tractors so that it would be necessary for him to stock five different greases, plus a sixth if he had an automatic greasing system requiring a rheopectic grease. The rheopectic grease would differ from the above in that it is a fluid grease which will change its consistency through the action of shear in a bearing or grease line of the automatic system. Two greases, a truly rheopectic grease and a truly multi-purpose grease, could handle all of the present and possibly future farm applications.

It is possible that one of the reasons for the acceptance of the sealed bearing on farm machinery is due to the confusion over what grease is to be applied in each piece of farm equipment. Certainly another reason why farmers have liked the sealed bearing on equipment such as corn pickers and combines is because there are now less than 20 fittings to be greased daily, whereas, in the past there may have been over 123 to be greased twice daily. This has meant a big reduction in labor and time the farmer formerly spent greasing.

The sealed bearing, according to one school of thought, may possibly replace all the non-sealed bearings on farm machinery. The correctness of their theory might be proven by some work that Mr. N. F. Andrews of the John Deere Co. did a few years ago. In his paper "Predicting Bearing and Seal Life Expectancy," he shows that a sealed bearing will last from two to three times longer than a bearing greased daily. The reasons for this, as stated in his paper, are: "One, when the bearing is greased daily, excess grease is forced through the seal and comes into contact with the sand, thus forming a good grinding compound. Second, the seal seats itself on the shaft. Each time grease is forced through the seal, the lips are raised. Since there is some end play in the shaft, the seal must reseat or wear a new line contact on the shaft."[2] It would seem then that from these tests it might be concluded that sealed bearings are the answer to better and more simplified farm lubrication.

Another school of thought will argue that the sealed bearing is *not* the answer for farm lubrication. One of the reasons that some people still feel that a greased bearing is better than a sealed bearing is due to the greater cost of the latter. The greater cost has been a very decided factor in the higher costs of equipment. Also when a "sealed-for-life bearing" does wear out, a farmer will usually replace it with a lower cost and lower quality sealed bearing. In some instances the author has heard of cases where sealed bearings were provided with a plug so that the farmer could insert a fitting. If the farmer does replace the plug with a grease fitting, he will soon find that he no longer has a "sealed" bearing. It seems that the economics of the sealed bearing may lead us to try other methods of simplifying grease lubrication upon a farm.

Another method of arriving at a maintenance-free bearing is the use of non-metallic, non-lubricated bearings. This type of bearing would eliminate lubrication due to the low frictional properties of materials such as Nylon, Teflon or Delrin. They would also eliminate the problem of rusting that is common in metallic farm bearings. At the present, the use of these bearings seems to be in the experimental state and little is published on their success in farm applications. Some unpublished information indicates that, due to the soft nature of these materials, abrasives such as sand will be embedded in the bearing and tend to grind the shaft causing shorter shaft life.

The use of sintered metal bearings is another possible method in which we can produce a maintenance-free bearing. One sintered metal bearing manufacturer, when contacted by the author, felt that in farm applications the problem of sealing out dirt and dust would be difficult to overcome. He recommended the use of a grease or oil to give the maximum protection against contaminants. However, there is little or no published information as to whether other people have tried sintered metal bearings on farm machinery and how successful the bearings were in these applications.

One other possibility for producing a maintenance-free bearing for low speed and low pressure applications could be a bonded film of either molybdenum disulfide or graphite. These dry lubricants could be bonded to the surface of the parts to be lubricated with either a phenolic or alkyd resin. Here again there is little or no published information as to their success in farm applications.

It might be well to point out that during this period of bearing development and experimentation, grease manufacturers and grease equipment manufacturers have not been sitting still. They have come up with some innovations that have greatly changed the grease picture on the farm. One of the most important of these is the true multi-purpose grease, which will stand more heat, but will pump well in cool weather. The farmer must have a grease that will pump in the dead of winter and will stay on the bearing when it becomes over-heated due to some abnormal loads put upon it. Increased yields of corn and other crops per foot per

row means much tougher work per acre for each piece of equipment. This increase in yield has been brought about by intensive fertilization and healthier plants due to the use of crop sprays.

During the last few years, the methods of handling greases have improved greatly. First of all, many farmers have switched from sucking grease out of the bucket and into the gun to the transfer method whereby a gun is filled more quickly and without air pockets. Another new method of handling grease is tubed grease. Despite the fact that tubed grease costs a few cents more per pound than bulk container grease, a farmer may save money through less waste, less contamination and ease of handling. Many farmers with hired men have found that the hired man will not always do the required greasing because he does not like to fill a gun and get his clothes greasy during the filling.

Two of the newest types of greasing equipment are the bank system and the automatic greasing system. The bank system is liked by many farmers because they can install the system by themselves. It is also liked because a farmer can grease many bearings on the underside of a piece of machinery without having to crawl under it. On one of the new 1961 farm tractors there is a bank system. The bank system has meant a great reduction in greasing time, plus the fact that a farmer does not get covered with grease from head to toe. The automatic greasing system is presently being used on corn pickers, combines, grain drills and other pieces of farm equipment. Presently there are three operational automatic farm lubrication systems. Two of these use either a rheopectic grease or just a semi-fluid grease, the other uses either an SAE 80 or SAE 90 gear lubricant. In the future, if the farmer is willing to pay the price of automatic lubrication, all the greasing could be done without the farmer ever having to stop during the day. However, the automatic greasing system will add an additional product in the form of a gear lubricant or a rheopectic grease.

It is conceivable, if the trend towards automatic lubrication continues, that future farms will only need a truly multi-purpose grease, plus either a gear lubricant or a rheopectic grease. This, the author feels, is not only possible, but also a necessity.

Transmission Oils

Figure 2 indicates the plight of the farmer regarding gear lubrication. This figure shows us that the manufacturers of *eight* recent diesel tractors recommended *eight* different gear lubricants. This means that each farmer with three or more tractors of different manufacture would have to stock three different gear oils. The local lubricant supplier is in worse shape because he would have to stock all eight lubricants, plus some more for older tractors. This great diversity in gear lubricant recommendations must be due to two things.

TRANSMISSION OILS

Transmission Oils	*Tractors*							
	A	B	C	D	E	F	G	H
OA Plus 10W/30	X							
Special G.O. No. 1		X						
Mil-L-002105A SAE 80			X					
St. Min. Gear SAE 90				X				
EP SAE 80					X			
MS-DG Oil or Special G.O. No. 2						X		
Special G.O. No. 3							X	
Type A								X

FIGURE 2

The first of these is farmer's need for and the desire of the tractor manufacturer to develop a ten or twelve speed transmission. The second is a lack of coordination between the research of lubricant manufacturers and tractor manufacturers.

There are several reasons why farmers want to have ten or twelve speed transmissions in their tractors. First of all, heavier yields per acre of farm crops have meant a reduction in harvesting speeds. It may be necessary for a farmer to pick a heavy yield of corn at less than 1 mph in order to let the corn be properly husked and without shelling the corn prematurely. Secondly, there are many farmers today farming more than one farm and they need to travel several miles between farms. In order to travel between farms without wasting time, a farmer needs a tractor that can travel at 20 mph. In the past the farmer was not able to get this necessary flexibility of gear ratios to allow him to move at less than 1 mph, or as fast as 20 mph. The farmer would also like to get finger-tip control. Finger-tip control is especially necessary when a farmer is plowing because, due to the changes in the ground hardness, he may have to shift gears hundreds of times per day. This would eliminate a great portion of the fatigue that a farmer experiences after plowing for ten hours.

At present there are at least three different ways a farmer can get more speed transmission, plus easier shifting. The first method would be the use of a two-speed planetary power shift gear unit ahead of an existing sliding gear countershaft transmission. The second method is the use of a torque converter. The latter solution is being used on many farm tractors today. The third possibility is the adaption of an automatic transmission, similar to those found on automotive equipment. Each of these could give the farmer more gear ratios, plus easier shifting. If this trend towards some type of automatic transmission continues, it should help us narrow the gear lubricants

down to one of the Type A variety, or some improvement of this type.

The author feels that the use of a limited slip differential could be one of the great advances in farm machinery. With the use of the limited slip differential, it would be possible to increase the drawbar pull of a tractor during plowing because the power would be transmitted to the wheel with traction. At present, weights are put on the side of the tractor where traction is desired.

Another great advance in farming would be the adoption of the 1000 rpm power take-off. It is possible with an increase from 540 rpm to 1000 rpm to increase the power of a 1¾ inch power take-off shaft 100 per cent. It may be necessary to change gear lubricants to meet the greater speed of the new power take-off system.

Even if these two innovations are used, and it is hoped that they will be, it still seems possible to have

HYDRAULIC OILS

(Ambient Temp. 80°F.)

Hydraulic Oils	*Tractors*							
	A	B	C	D	E	F	G	H
OA Plus 10W	X							
Special Oil No. 1		X						
Special Oil No. 2			X					
20W Motor Oil				X	X			
Type A						X		X
Special Oil No. 3							X	

FIGURE 3

one gear lubricant upon future farms. This will, however, require the efforts of all of us to bring this about.

Hydraulic Oils

Figure 3 shows the current state of hydraulic oil recommendations among the eight diesel tractors. It may be noted that only 50 per cent of the tractors recommended a hydraulic oil that can be used on other tractors. The diversity of hydraulic oils will become more of a problem to the farmer and the lubricant manufacturer, if the trend toward more hydraulic-operated equipment continues. If the use of a common oil (transmission, differential and hydraulic) expands, it is possible that the problem of too many hydraulic oils can be solved.

However, there are several new things that may alter the picture of fewer hydraulic oils. The first of these is the four-wheel-drive tractors for farm use. One manufacturer this year has commercially produced a small number of these large tractors. It is possible that if the trend towards these large four-wheel-drive tractors continues, it will be necessary to have a central hydraulic system so one man can easily operate the tractor. This central hydraulic system would also help the operator in performing tasks such as plowing. This new tractor is capable of pulling nine mounted 16 inch bottom plows or twelve pull-type 16 inch bottom plows. This means that the tractor must lift these plows out of the ground at the end of the field. Work of this magnitude may require a special hydraulic oil.

In the future it is probable that we will see more farmers doing heavy field work such as plowing with the use of tandem tractors. In a typical tandem tractor arrangement, the front wheels of both tractors are removed and the rear tractor is then placed upon a receptacle on the drawbar of the forward tractor. With this arrangement one man can do more work than two men working the tractors separately. In many instances the author has seen farmers plow more than 50 acres in one ten-hour day by themselves. Normally the rear tractor in a tandem hook-up operates the hydraulic cylinder on the implement drawn by the tractor. It is possible that the rear tractors can be switched around each time the two tractors are joined into a tandem tractor. This means that at one time Tractor A may be supplying the hydraulic oil, whereas, at another time Tractor B might supply the oil.

This would mean a mixing of hydraulic oils in the cylinder as well as in the hydraulic system on the tractor. This would be just one more reason why *one* hydraulic oil is necessary on the farm.

Through coordination, the author believes, we can reduce the number of hydraulic oils required for farm machinery to just *one*. This reduction would benefit the farmer, oil supplier and tractor manufacturer through lower costs, less chance of error and fewer oils.

Motor Oils

Figure 4 is a pleasant change from the other figures compiled from the manufacturers' recommendations. Here we note that recommendations by manufacturer only vary in viscosity, if we impose the following conditions: sulfur content in excess of 0.5 per cent, atmospheric temperature of 80°F., and taking the manufacturers' recommendation for *severe* service. By imposing the above conditions, all the manufacturers

MOTOR OILS*

Motor Oils	*Tractors*							
	A	B	C	D	E	F	G	H
Series 3 SAE 30		X			X		X	X
Series 3 SAE 20	X		X	X		X		

*Ambient Temp. 80°F. Sulfur Content Above 0.5%. Manufacturers' Recommendation for *Severe* Service

FIGURE 4

MOTOR OIL CHANGE PERIODS

Service Intervals (Hrs.)	*Tractors*							
	A	B	C	D	E	F	G	H
60	X							
75					X			
100			X				X	X
120						X		
150				X				
250		X						

FIGURE 5

would recommend either an SAE 20 or an SAE 30 Series 3 lubricating oil. However, Figure 5 shows a different story. It can be noted that tractors A and B differ greatly in service intervals. Even though Tractor A has a crankcase capacity of two-thirds of Tractor B, it must be changed *four* times as often. A farmer owning both of these tractors will soon wonder why there is so much difference in oil change periods. Often the farmer will take it upon himself to change the oil when he thinks it is time or at some interval of time that is easy to remember.

It must be pointed out at this time that the great diversity of service intervals is not only true with motor oil change periods, but also it is true with wheel bearing greasing intervals, and transmissions and hydraulic oils drain periods. The author feels very strongly that some system of service intervals should be installed among the tractor and farm implement manufacturers to simplify maintenance for farmers. A system that could be adapted is one similar to that proposed by the Construction and Industrial Machinery Technical Committee of the SAE. This system would mean that all farm equipment might be serviced at hourly intervals such as: 10, 50, 100, 250, 500, 1000 and 2000 hours. These hourly intervals would be easier to follow with an hour meter.

If this system of universal service intervals could be adopted, it would help the farmer with diesel tractors as well as those with either gasoline or LPG-powered tractors. Today the tractors powered by LPG and gasoline are in the middle of a controversy as to what oil should be used in them. Even the lubricant supplier is somewhat in doubt as to when an MM and ML oil should be recommended instead of an MS-DG or HD oil. Soon there will have to be a meeting of the minds to settle for once and all the nomenclature regarding the classification of oils according to the expected service. As soon as the manufacturers of tractors and oils can talk in the same terms, it may be possible to recommend one oil for all non-diesel tractors. The author feels that the adoption of *one* medium detergent oil such as an oil meeting the MS-DG service requirements, could properly lubricate all non-diesels.

In conclusion, the author feels that in order for farm machinery to continue improving at the present rate it will be necessary to have no more than six lubricants: a rheopectic grease, a truly multi-purpose grease, a transmission fluid, a hydraulic oil, a MS-DG service oil and a Series 3 oil. The author also feels that the adoption of a system similar to the one proposed by the CIMTC would help the farmer immensely. Unless we reduce the number of lubricants and get a standard service interval system, it will mean that farmers will have to hire a lubrication engineer or take the equipment to a farm dealer for service. This would be impractical, as well as costly, so it is up to us to work hand-in-hand in the future with the equipment manufacturer to develop sound lubrication methods for all farm machinery.

Bibliography

1. "Machine Age Boon to Farmers," UPI dispatch from State-Federal Crop Reporting Service as printed on May 4, 1960 in the *Chicago Daily News*.
2. "Predicting Bearing and Seal Life Expectancy," N. F. Andrews as published in the December, 1958 edition of *Agricultural Engineering*, pages 750-753.
3. "The Contractor's Partner—The Lubricant Supplier," D. J. Rosselle and R. J. Brossman, presented before NLGI in October, 1957.
4. "Farm Tractor Lubrication Guide," Chek-Chart Corporation, 1959.
5. "New 1000 RPM Power Take-Off Standard Approved," by James Basselman, *Agricultural Engineering*, February, 1958, pages 83-85.
6. "1000 RPM Power Take-off for Farm Tractors," *Agricultural Engineering*, February, 1958, pages 86-88.
7. "Tractor Transmission Responds to Finger-Tip Control," R. L. Erwin and G. T. O'Harrow, *Agricultural Engineering*, April, 1959, pages 198-207.

About the Author

W. A. Magie, Jr., *received an AB degree in petroleum geology from Harvard college in 1953. Shortly after graduation, he received a commission in the U. S. Naval Reserve and spent the next two years aboard a Pacific Coast destroyer. Released to inactive duty in 1955, he spent the next year working in the laboratory at Magie Bros. Oil Co. In 1956 he joined the Taleen Oil Co. as a farm lubricant salesman covering the central part of Illinois. In 1959 he returned to Magie Bros. Oil Co. as an industrial salesman. Mr. Magie is a member of SAE and is director of the Chicago section of ASLE.*

Index to NLGI SPOKESMAN, Vol. XXIV

April, 1960 - March, 1961

INDEX BY AUTHORS

Armstrong, E. L., *Review of Research Studies Showing Need for a Viscosity Test Below 1 Sec.$^{-1}$ (Dispensing Symposium–5)*, 5, XXIV, August, 1960

Armstrong, J. W., *Greases for Extreme Environments*, 6, XXIV, September, 1960
Co-authors, J. R. Handschy, D. E. Loeffler

Bailey, C. A., *Bulk Grease Handling (Dispensing Symposium–4)*, 4, XXIV, July, 1960

Bauer, W. H., *Infrared Studies of Greases*, 8, XXIV, November, 1960
Co-authors, S. E. Wiberley, D. B. Cox

Belt, J. R., *Grease Evaluation by Bearing Performance Tests*, 1, XXIV, April, 1960
Co-author, N. Glassman

Brunstrum, L. C., *Non-Soap Lubricating Greases*, 7, XXIV, October, 1960

Brunstrum, L. C., *Spotlighting Our Dispensing Problems (Dispensing Symposium–6)*, 5, XXIV, August, 1960

Burke, J. J., *Oxidation of Lubricating Greases*, 10, XXIV, January, 1961
Co-author, J. E. Goodrich

Carter, C. F., *A New Technique for Continuous Measurement of Grease Consistency During Manufacture (Manufacturing Symposium–4)*, 6, XXIV, September, 1960
Co-author, J. L. Dreher

Carter, C. F., *Rapid Method for Predicting the Flow Properties of Lubricating Greases*, 11, XXIV, February, 1961

Cox, D. B., *Infrared Studies of Greases*, 8, XXIV, November, 1960
Co-authors, W. H. Bauer, S. E. Wiberley

Dooley, A. E., *The 1958 Food Additives Amendment—Its Effect on the Lubrication of Food Packaging Machinery*, 10, XXIV, January, 1961

Dreher, J. L., *A New Technique for Continuous Measurement of Grease Consistency During Manufacture (Manufacturing Symposium–4)*, 6, XXIV, September, 1960
Co-author, C. F. Carter

Ehrlich, M., *The NLGI Dispensing Method, Comment on Papers by R. D. Skoglund and W. L. Gabbert*, 2, XXIV, May, 1960

Ehrlich, M., *A Philosophy of Grease Milling (Manufacturing Symposium–5)*, 7, XXIV, October, 1960
Co-author, F. S. Sayles

Eldridge, H., *Lubricating Grease Requirements of the 1961 Cars*, 8, XXIV, November, 1960

Ewbank, W. J., *Definitions of Terms Relating to the Lubricating Grease Industry, Part III*, 2, XXIV, May, 1960

Forster, E. O., *A Rheological Equation for Lubricating Greases*, 12, XXIV, March, 1961

Gabbert, W. L., *Development of a Chart for Predicting the Pumpability of Greases (Dispensing Symposium–2)*, 2, XXIV, May, 1960

Garretson, R. C., *Westinghouse Grease Dispensing Practice (Dispensing Symposium–3)*, 3, XXIV, June, 1960

Glassman, N., *Grease Evaluation by Bearing Performance Tests*, 1, XXIV, April, 1960
Co-author, J. R. Belt

Goodrich, J. E., *Oxidation of Lubricating Greases*, 10, XXIV, January, 1961
Co-author, J. J. Burke

Guzzo, C. J., *The Challenge of the Sixties to the Grease Industry*, 8, XXIV, November, 1960

Handschy, J. R., *Greases for Extreme Environments*, 6, XXIV, September, 1960
Co-authors, J. W. Armstrong, D. E. Loeffler

Harris, D. N., *Aero / Space Grease Requirement Trends*, 11, XXIV, February, 1961

Hendricks, S. E., *Material Handling and Processing Aids in the Manufacturing of Grease (Manufacturing Symposium–3)*, 4, XXIV, July, 1960
Co-author, R. S. Stoops

Hosler, W. R., *Grease Containers–Past, Present and Future*, 1, XXIV, April, 1960

Hotten, B. W., *Effect of Oil Viscosity on Rheological Properties of Lubricating Greases*, 7, XXIV, October, 1960
Co-author, A. L. McClellan

Johnson, C. L., *Selling the Lubricating Grease Market*, 11, XXIV, February, 1961

Kolfenbach, J. J., *New Thickener System Extends Range of Multipurpose Greases*, 5, XXIV, August, 1960
Co-author, A. J. Morway

Loeffler, D. E., *Greases for Extreme Environments*, 6, XXIV, September, 1960
Co-authors, J. W. Armstrong, J. R. Handschy

McClellan, A. L., *Effect of Oil Viscosity on Rheological Properties of Lubricating Greases*, 7, XXIV, October, 1960
Co-author, B. W. Hotten

McNichol, M. A., *A Co-op First—Rapeseed Oil Grease*, 10, XXIV, January, 1961

Magie, Jr., W. A., *What's Ahead in Farm Machinery Lubrication*, 12, XXIV, March, 1961

Mayor, Jr., H. A., *President's Address—1960*, 9, XXIV, December, 1960

Morway, A. J., *New Thickener System Extends Range of Multipurpose Greases*, 5, XXIV, August, 1960
Co-author, J. J. Kolfenbach

NLGI GLOSSARY—Definitions of Terms Relating to the Lubricating Grease Industry: Parts I, II & III, 4, XXIV, July, 1960

NLGI's New Promotion Character, Introducing, 11, XXIV, February, 1961

Noll, C. R., *Background and Current Status of the A.P.I. GL-4 Designation for Automotive Gear Lubricants*, 6, XXIV, September, 1960

Sayles, F. S., *A Philosophy of Grease Milling (Manufacturing Symposium—5)*, 7, XXIV, October, 1960
Co-author, M. Ehrlich

Shaffer, T. F., *An Interpretation of NLGI's 1959 Production Survey*, 9, XXIV, December, 1960

Skoglund, R. D., *A Review of NLGI's Tentative Dispensing Method (Dispensing Symposium—1)*, 2, XXIV, May, 1960

Stoops, R. S., *Material Handling and Processing Aids in the Manufacturing of Grease (Manufacturing Symposium—3)*, 4, XXIV, July, 1960
Co-author, S. E. Hendricks

Stratford, H. W., *Review and Forecast of Grease Manufacture (Manufacturing Symposium—1)*, 1, XXIV, April, 1960

Suggitt, R. M., *Structural Changes and Phase Transitions in Lithium Greases*, 9, XXIV, December, 1960

Timm, K. G., *Grease Mixer Design (Manufacturing Symposium—2)*, 3, XXIV, June, 1960

Van Alden, F. A., *Transportation Savings*, 3, XXIV, June, 1960

Wiberley, S. E., *Infrared Studies of Greases*, 8, XXIV, November, 1960
Co-authors, W. H. Bauer, D. B. Cox

Young, W. R., *Chassis Grease Sparks Canadian Customer Campaign*, 4, XXIV, July, 1960

INDEX BY TITLES

Aero/Space Grease Requirement Trends, D. N. Harris, 11, XXIV, February, 1961

Background and Current Status of the A.P.I. GL-4 Designation for Automotive Gear Lubricants, C. R. Noll, 6, XXIV, September, 1960

Bulk Grease Handling (Dispensing Symposium—4), C. A. Bailey, 4, XXIV, July, 1960

The Challenge of the Sixties to the Grease Industry, C. J. Guzzo, 8, XXIV, November, 1960

Chassis Grease Sparks Canadian Customer Campaign, W. R. Young, 4, XXIV, July, 1960

A Co-op First—Rapeseed Oil Grease, M. A. McNichol, 10, XXIV, January, 1961

Definitions of Terms Relating to the Lubricating Grease Industry, Part III, W. J. Ewbank, 2, XXIV, May, 1960

Development of a Chart for Predicting the Pumpability of Greases (Dispensing Symposium—2), W. L. Gabbert, 2, XXIV, May, 1960

Effect of Oil Viscosity on Rheological Properties of Lubricating Greases, B. W. Hotten, A. L. McClellan, 7, XXIV, October, 1960

The 1958 Food Additives Amendment—Its Effect on the Lubrication of Food Packaging Machinery, A. E. Dooley, 10, XXIV, January, 1961

Grease Containers—Past, Present and Future, W. R. Hosler, 1, XXIV, April, 1960

Grease Evaluation by Bearing Performance Tests, J. R. Belt, N. Glassman, 1, XXIV, April, 1960

Greases for Extreme Environments, J. W. Armstrong, J. R. Handschy, D. E. Loeffler, 6, XXIV, September, 1960

Grease Mixer Design (Manufacturing Symposium–2), K. G. Timm, 3, XXIV, June, 1960

Infrared Studies of Greases, W. H. Bauer, D. B. Cox, S. E. Wiberley, 8, XXIV, November, 1960

An Interpretation of NLGI's 1959 Production Survey, T. F. Shaffer, 9, XXIV, December, 1960

Introducing NLGI's New Promotion Character, 11, XXIV, February, 1961

Lubricating Grease Requirements of the 1961 Cars, H. Eldridge, 8, XXIV, November, 1960

Material Handling and Processing Aids in the Manufacturing of Grease (Manufacturing Symposium–3), S. E. Hendricks, R. S. Stoops, 4, XXIV, July, 1960

A New Technique for Continuous Measurement of Grease Consistency During Manufacture (Manufacturing Symposium–4), C. F. Carter, J. L. Dreher, 6, XXIV, September, 1960

New Thickener System Extends Range of Multipurpose Greases, J. J. Kolfenbach, A. J. Morway, 5, XXIV, August, 1960

The NLGI Dispensing Method, Comment on Papers by R. D. Skoglund and W. L. Gabbert, M. Ehrlich, 2, XXIV, May, 1960

NLGI GLOSSARY–Definitions of Terms Relating to the Lubricating Grease Industry: Parts I, II & III, 4, XXIV, July, 1960

Non-Soap Lubricating Greases, L. C. Brunstrum, 7, XXIV, October, 1960

Oxidation of Lubricating Greases, J. J. Burke, J. E. Goodrich, 10, XXIV, January, 1961

A Philosophy of Grease Milling (Manufacturing Symposium–5), M. Ehrlich, F. S. Sayles, 7, XXIV, October, 1960

President's Address–1960, H. A. Mayor, Jr., 9, XXIV, December, 1960

Rapid Method for Predicting the Flow Properties of Lubricating Greases, C. F. Carter, 11, XXIV, February, 1961

Review and Forecast of Grease Manufacture (Manufacturing Symposium–1), H. W. Stratford, 1, XXIV, April, 1960

A Review of NLGI's Tentative Dispensing Method (Dispensing Symposium–1), R. D. Skoglund, 2, XXIV, May, 1960

Review of Research Studies Showing Need for a Viscosity Test Below 1 Sec. $^{-1}$ *(Dispensing Symposium –5)*, E. L. Armstrong, 5, XXIV, August, 1960

A Rheological Equation for Lubricating Greases, E. O. Forster, 12, XXIV, March, 1961

Selling the Lubricating Grease Market, C. L. Johnson, 11, XXIV, February, 1961

Spotlighting Our Dispensing Problems (Dispensing Symposium–6), L. C. Brunstrum, 5, XXIV, August, 1960

Structural Changes and Phase Transitions in Lithium Greases, R. M. Suggitt, 9, XXIV, December, 1960

Westinghouse Grease Dispensing Practice (Dispensing Symposium–3), R. C. Garretson, 3, XXIV, June, 1960

What's Ahead in Farm Machinery Lubrication, W. A. Magie, Jr., 12, XXIV, March, 1961

Transportation Savings, F. A. Van Alden, 3, XXIV, June, 1960

INDEX BY CATEGORY

DEFINITIONS OF TERMS

Definitions of Terms Relating to the Lubricating Grease Industry, Part III, W. J. Ewbank, 2, XXIV, May, 1960

NLGI GLOSSARY–Definitions of Terms Relating to the Lubricating Grease Industry: Parts I, II & III, 4, XXIV, July, 1960

GEAR LUBRICANTS

Background and Current Status of the A.P.I. GL-4 Designation for Automotive Gear Lubricants, C. R. Noll, 6, XXIV, September, 1960

GENERAL

The Challenge of the Sixties to the Grease Industry, C. J. Guzzo, 8, XXIV, November, 1960

Introducing NLGI's New Promotion Character, 11, XXIV, February, 1961

President's Address–1960, H. A. Mayor, Jr., 9, XXIV, December, 1960

LUBRICATING GREASE

Application

Aero/Space Grease Requirement Trends, D. N. Harris, 11, XXIV, February, 1961

The 1958 Food Additives Amendment–Its Effect on the Lubrication of Food Packaging Machinery, A. E. Dooley, 10, XXIV, January, 1961

Greases for Extreme Environments, J. W. Armstrong, J. R. Handschy, D. E. Loeffler, 6, XXIV, September, 1960

What's Ahead in Farm Machinery Lubrication, W. A. Magie, Jr., 12, XXIV, March, 1961

CONTAINERS

Grease Containers–Past, Present and Future, W. R. Hosler, 1, XXIV, April, 1960

FLOW PROPERTIES OF LUBRICATING GREASES

Rapid Method for Predicting the Flow Properties of Lubricating Greases, C. F. Carter, 11, XXIV, February, 1961

MANUFACTURE

Manufacturing Symposium–1: Review and Forecast of Grease Manufacture, H. W. Stratford, 1, XXIV, April, 1960

Manufacturing Symposium–2: Grease Mixer Design, K. G. Timm, 3, XXIV, June, 1960

Manufacturing Symposium–3: Material Handling and Processing Aids in the Manufacturing of Grease, S. E. Hendricks, R. S. Stoops, 4, XXIV, July, 1960

Manufacturing Symposium–4: A New Technique for Continuous Measurement of Grease Consistency During Manufacture, C. F. Carter, J. L. Dreher, 6, XXIV, September, 1960

Manufacturing Symposium–5: A Philosophy of Grease Milling, M. Ehrlich, F. S. Sayles, 7, XXIV, October, 1960

NON-SOAP

Non-Soap Lubricating Greases, L. C. Brunstrum, 7, XXIV, October, 1960

PRODUCTION FIGURES

An Interpretation of NLGI's 1959 Production Survey, T. F. Shaffer, 9, XXIV, December, 1960

REQUIREMENTS

Lubricating Grease Requirements of the 1961 Cars, H. Eldridge, 8, XXIV, November, 1960

RHEOLOGICAL PROPERTIES

Effect of Oil Viscosity on Rheological Properties of Lubricating Greases, B. W. Hotten, A. L. McClellan, 7, XXIV, October, 1960

A Rheological Equation for Lubrication Greases, E. O. Forster, 12, XXIV, March, 1961

STRUCTURAL CHANGES AND PHASE TRANSITIONS IN LITHIUM GREASES

Structural Changes and Phase Transitions in Lithium Greases, R. M. Suggitt, 9, XXIV, December, 1960

TESTING

Dispensing Symposium–1: A Review of NLGI's Tentative Dispensing Method, R. D. Skoglund, 2, XXIV, May, 1960

Dispensing Symposium–2: Development of a Chart for Predicting the Pumpability of Greases, W. L. Gabbert, 2, XXIV, May, 1960

Dispensing Symposium–3: Westinghouse Grease Dispensing Practice, R. C. Garretson, 3, XXIV, June, 1960

Dispensing Symposium–4: Bulk Grease Handling, C. A. Bailey, 4, XXIV, July, 1960

Dispensing Symposium–5: Review of Research Studies Showing Need for a Viscosity Test Below 1 Sec.$^{-1}$, E. L. Armstrong, 5, XXIV, August, 1960

Dispensing Symposium–6: Spotlighting Our Dispensing Problems, L. C. Brunstrum, 5, XXIV, August, 1960

Grease Evaluation by Bearing Performance Tests, J. R. Belt, N. Glassman, 1, XXIV, April, 1960

Infrared Studies of Greases, W. H. Bauer, D. B. Cox, S. E. Wiberley, 8, XXIV, November, 1960

The NLGI Dispensing Method, Comment on Papers by R. D. Skoglund and W. L. Gabbert, M. Ehrlich, 2, XXIV, May, 1960

Oxidation of Lubricating Greases, J. J. Burke, J. E. Goodrich, 10, XXIV, January, 1961

THICKENERS

New Thickener System Extends Range of Multipurpose Greases, J. J. Kolfenbach, A. J. Morway, 5, XXIV, August, 1960

MARKETING

Chassis Grease Sparks Canadian Customer Campaign, W. R. Young, 4, XXIV, July, 1960

A Co-op First–Rapeseed Oil Grease, M. A. McNichol, 10, XXIV, January, 1961

Selling the Lubricating Grease Market, C. L. Johnson, 11, XXIV, February, 1961

TRANSPORTATION

Transportation Savings, F. A. Van Alden, 3, XXIV, June, 1960

Literature and Patent Abstracts

Composition

Lubricating Greases Containing Calcium Acetate

In British Patent 844,426, Esso Research and Engineering Co. suggests a method for preventing settling of calcium acetate dispersions in oil. This consists of addition of 0.1 to 10 per cent of certain amines. The preferred amines are tertiary alkyl primary amines such as Primene JM-T which is a commercial material consisting of a mixture of C_{18-24} tertiary alkyl primary amines.

For example, a lubricating grease was made from the following in weight per cents: 25 glacial acetic acid; 17 hydrated lime; 2 Primene JM-T; and 56 of a mineral oil having a viscosity of 80 SUS at 210°F. The oil, lime and amine were intimately mixed in a steam-jacketed kettle. The acetic acid was then slowly added while mixing was continued. This caused the temperature to rise to 220°F while a heavy mass formed. After mixing for one-half hour, external heat was applied to raise the temperature to 320°F. This temperature was maintained for about 30 minutes to insure complete dehydration and formation of anhydrous calcium acetate. The mixture was then cooled, while stirring, to about 100°F after which it was passed through a Gaulin homogenizer operating at about 6000 psi shear.

This gave a thixotropic smooth product which set to a soft solid on standing at rest but fluidized on exertion of shearing stress. When this lubricant was subjected to a 4-Ball wear test conducted at 75°C, 1800 rpm, for one hour with a 10 kg load, a scar diameter of 0.26 mm. was obtained.

Organophilic Bentonite As a Lubricant Thickener

Shao-Li Ch'en and Wei-Yung Hsu in Jan Liao Hsueh Pao 4, 391-6 (1959) describe experiments with a calcium bentonite from Liaonin province in China. This was first

FATTY ACIDS by A. GROSS provide

- Controlled fatty acid radical content
- Controlled purity content
- Ease of saponification
- Resistance to oxidation
- Shipment to shipment uniformity
- Light color

GROCO 41 DISTILLED TALLOW FATTY ACIDS

Titre	40°-43°C
Color 5¼" Lovibond Red	1-2
Color 5¼" Lovibond Yellow	10-20
Color Gardner 1933	3 max.
Unsaponifiable	1.0% max.
Saponification Value	200-205
Acid Value	199-204
% F.F.A. as Oleic Acid	100.0 min.
Iodine Value (WIJS)	55 max.

a. gross & COMPANY

ALWAYS MEASURABLY BETTER THAN THE SPECIFICATIONS CALL FOR

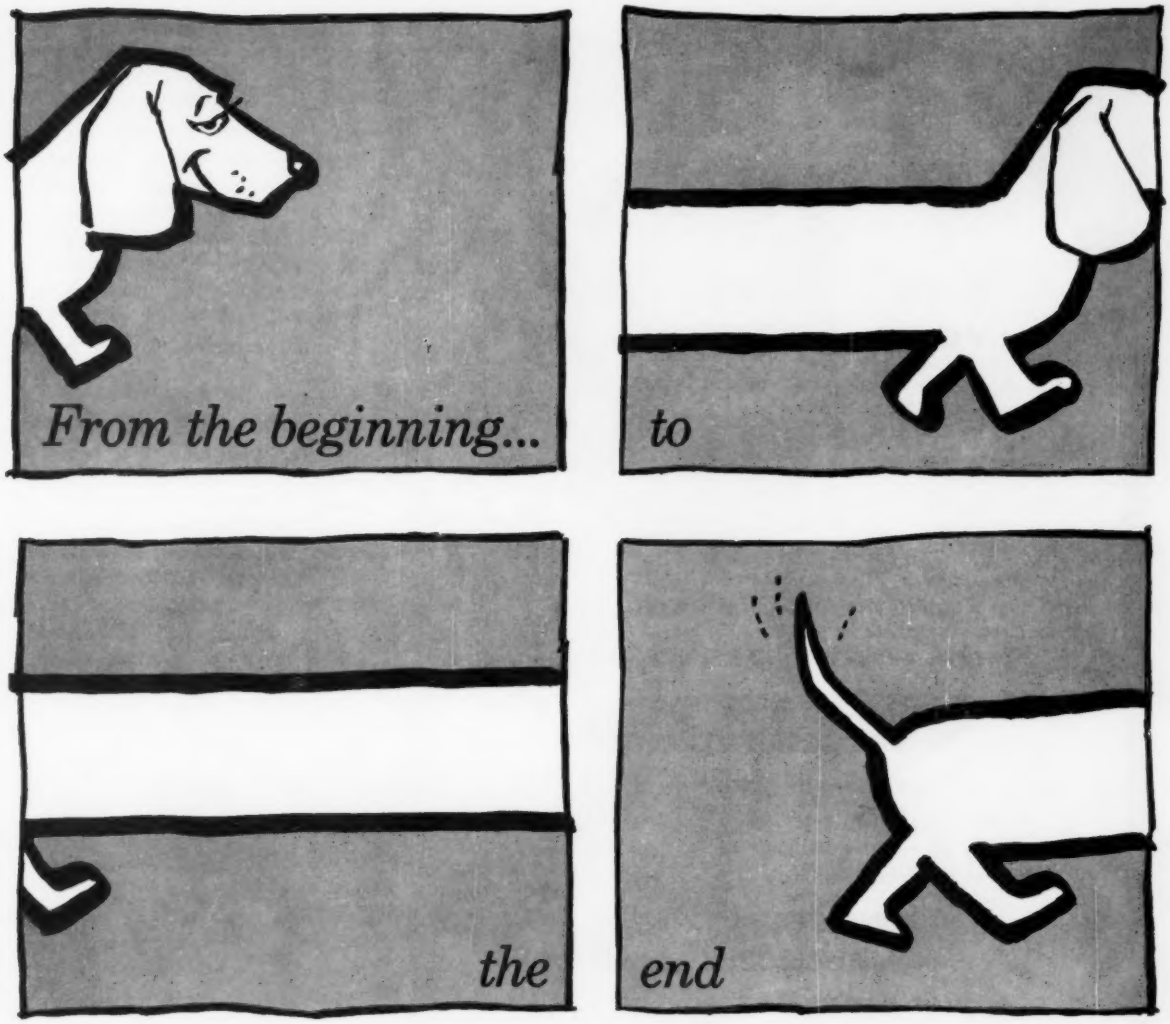
COMPOSITION

Myristic Acid	3%
Palmitic Acid	29%
Stearic Acid	15%
Oleic Acid	47%
Linoleic Acid	5.5%
Linolenic Acid	0.5%

295 Madison Ave., N. Y. 17, N. Y.
Factory: Newark, New Jersey

Distributors in principal cities
Manufacturers since 1837

Write for new edition of the free brochure, "Fatty Acids in Modern Industry."



Baker does it all

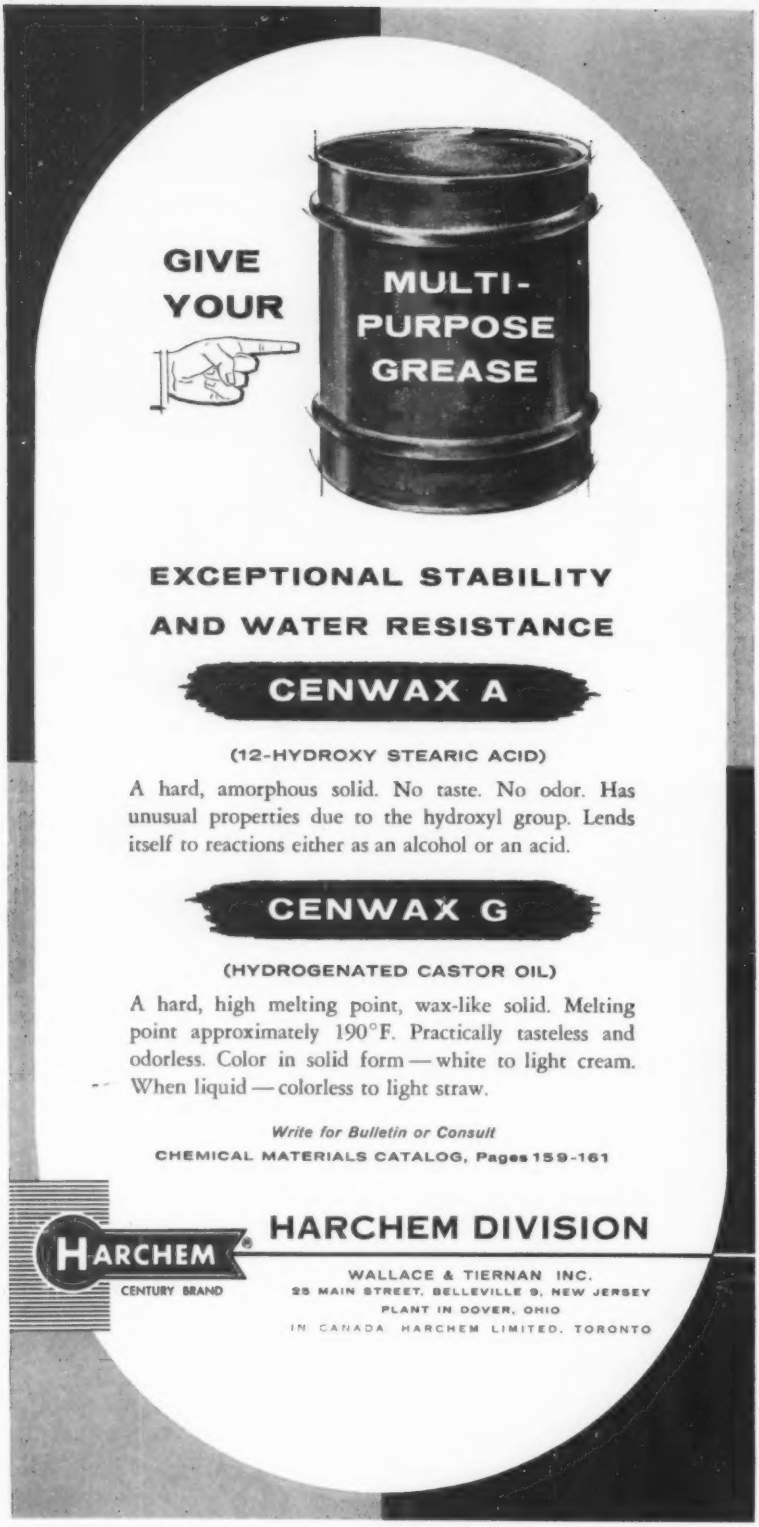
The best dog in the world couldn't sniff out a middleman in the production of Baker's hydrogenated castor oil derivatives. From the selection of the raw castor beans to production of the finished chemicals—Baker does it all. Having a hand in all phases of the manufacture of castor oil derivatives has been Baker's business for over 100 years.

This start-to-finish responsibility assures you of uniform quality and steady supply of **Baker's hydrogenated castor oil,** *(Castorwax®),* **hydroxystearic acid, and methyl hydroxystearate.** It also means that by the bag or carload, Baker—the world's largest and most experienced producer of castor oil derivatives—is your prime source of supply.

Let us fill your next requirement. We will deliver what you need when you want it. Baker plants at Bayonne and Los Angeles, offices and warehouses in principal cities.

8019

the **Baker** castor oil company
ESTABLISHED 1857
BAYONNE, NEW JERSEY


GIVE
YOUR
MULTI-
PURPOSE
GREASE
EXCEPTIONAL STABILITY
AND WATER RESISTANCE
CENWAX A
(12-HYDROXY STEARIC ACID)
A hard, amorphous solid. No taste. No odor. Has unusual properties due to the hydroxyl group. Lends itself to reactions either as an alcohol or an acid.
CENWAX G
(HYDROGENATED CASTOR OIL)
A hard, high melting point, wax-like solid. Melting point approximately 190°F. Practically tasteless and odorless. Color in solid form — white to light cream. When liquid — colorless to light straw.
Write for Bulletin or Consult
CHEMICAL MATERIALS CATALOG, Pages 159-161
HARCHEM
CENTURY BRAND
HARCHEM DIVISION
WALLACE & TIERNAN INC.
25 MAIN STREET, BELLEVILLE 9, NEW JERSEY
PLANT IN DOVER, OHIO
IN CANADA: HARCHEM LIMITED, TORONTO

converted to a sodium bentonite by treatment with sodium hydroxide. The sodium bentonite was then reacted with a chloride of an aliphatic quaternary ammonium compound. The aminated bentonite, when dispersed in lubricating oil with butyl alcohol as the dispersant, formed a lubricating grease.

Cable Pulling Lubricant

A lubricant for use in pulling cables through metal conduits is described by Sand, Wygant and Mecozzi in U.S. Patent 2,956,019, assigned to Standard Oil Co. (Indiana). Such a lubricant should have good adherence to the cable but should not deteriorate the insulation, cake or cement upon drying, nor cause short circuits on rubber or fabric-covered cables.

Such characteristics are secured, according to the authors, with a mixture of 60 to 65 weight per cent of glycerine, 25 to 30 weight per cent of sodium bentonite, 5 to 10 weight per cent of talc which will pass a 300 mesh screen, and 2.5 to 1.5 weight per cent of an anionic foam-forming detergent containing an alkyl aryl sulfonate and inorganic sodium salts.

The lubricant is compounded by first thoroughly mixing the glycerine and the bentonite, then by mixing in the talc followed by incorporating the detergent. Mixing is best done in a dough mixer with the final mixing at a minimum speed of 300 rpm to form foam. The lubricant is preferably foamed to a density of seven to eight pounds per gallon. The desired spongy consistency is such that, using a 30 gram cone with a Grease Penetrometer, the unworked penetration is about 250. Such a consistency is easily handled and can be applied without dripping.

Oxidation Inhibitor for Lubricating Greases

Hotten in U.S. Patent 2,954,342, assigned to California Research Corp., describes oxidation inhibitors for lubricating greases which have dropping points above 350°F.

Such additives have low volatility and good stability within the high temperature range.

The inhibitors consist of certain amides of ethylenediaminetetra-acetic acid, and/or certain homologues. For example, 50 grams of ethylenediaminetetra-acetic acid and 156 grams of octadecylamine (Armeen HT) were reacted by mixing and heating to 400°F until evolution of water had ceased. The resulting crude product was recrystallized from ethyl alcohol to yield a cream-colored solid melting at 90 to 96°F.

Five grams of this recrystallized product were mixed with 95 grams of a lithium base lubricating grease and the mass was heated to 200°F to disperse the additive. The particular grease used consisted of 88 parts by weight of a solvent refined California paraffin base oil having a viscosity of 480 SUS at 100°F, the oil being thickened with 12 parts by weight of lithium stearate.

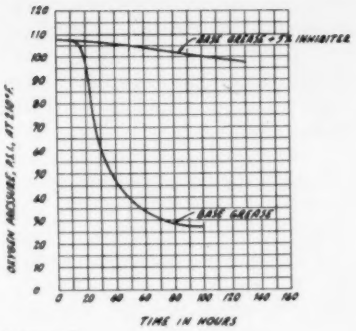


Figure 1.

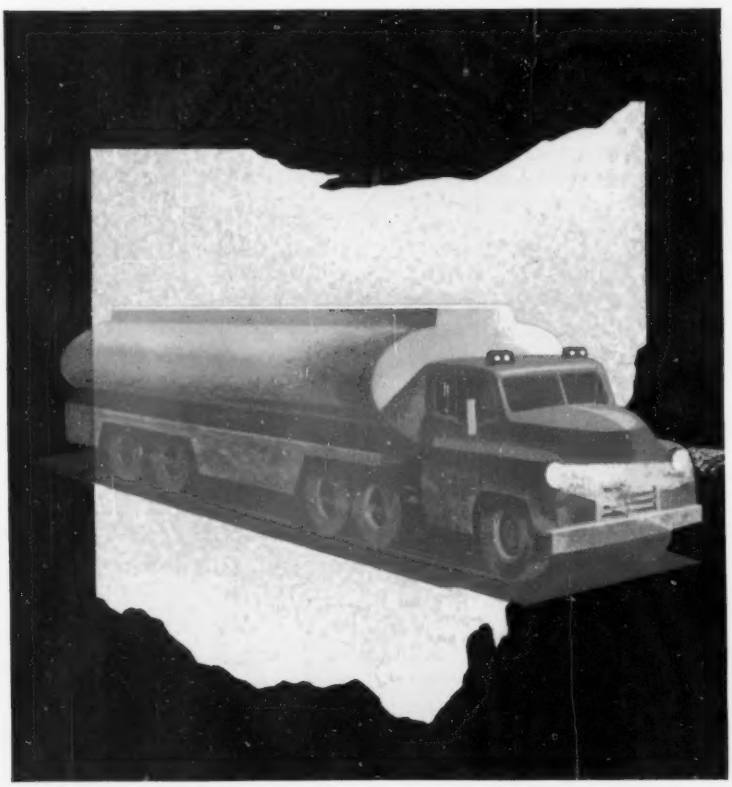
Samples of both the untreated grease and that containing the inhibitor were subjected to Bomb Oxidation Tests. The results of such tests are indicated in Figure 1 where it is evident that the additive in question was of value.

High Melting Point EP Lubricating Greases

By including metal salts of certain aromatic acids in lubricating greases also containing sodium terephthalamates, the dropping point is raised and EP qualities are conferred to the composition. A description of such lubricants is given by Hotten in U.S. Patent 2,956,022, assigned to California Research Corp.

Benzoic acid is the preferred aromatic acid. The lubricating greases are formed by co-reacting esters of terephthalamic acid and benzoic acid with sodium hydroxide in the presence of mineral oil, dehydrating, cooling and milling.

Thus, a lubricating grease consisting of 76 per cent of a California solvent refined naphthenic base oil having a viscosity of 1705 SUS at 100°F, 6 per cent of sodium n-octadecyl terephthalamate, 17 per cent sodium benzoate and 1 per cent glycerol, had a dropping point of 580+ F, a worked penetration of 203 and a Falex E.P. Test of 2,030 pounds.



SOHIO

BRINGS YOU THE QUALITY STOCK OILS YOU NEED...

WHEN AND WHERE YOU NEED THEM!

You're assured of prompt delivery of stock oils when you make Sohio your source of supply. That's because of Sohio's complete distribution system that brings stock oils to you on time, anyplace in the Midwest. And Sohio offers a complete line of high quality, dependable stock oils—paraffin or solvent—to completely meet the needs of any compounder or grease maker. Contact us now.

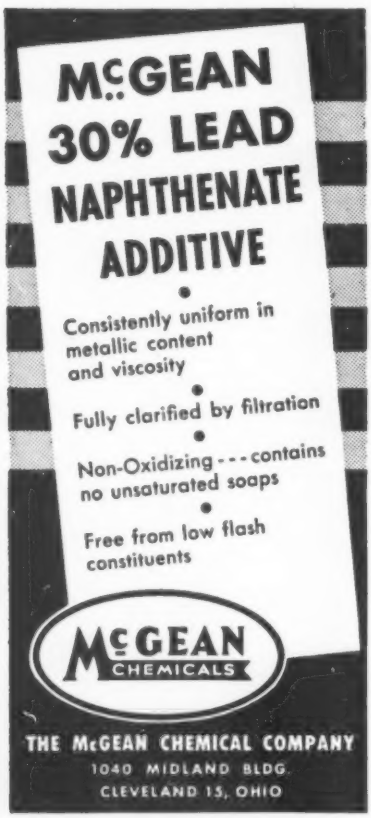
MIDLAND BLDG., CLEVELAND 15, OHIO

SOHIO

Metal Terephthalamate-Thickened Lubricating Greases Inhibited Against Bleeding

High temperature bleeding of lubricating greases, in which the thickeners are metal salts of terephthalamic acids, is retarded by the addition of 0.5 to 5 per cent by weight of alkali metal or alkaline earth metal soaps of unsubstituted fatty acids. This suggestion is given by Hotten in U.S. Patent 2,956,021, assigned to California Research Corp.

Thus, a mixture was made of a lubricating grease in which the thickener was sodium terephthalamate and another in which the thickener was sodium tallowate. In one case the final mixture contained 10.3 per cent of sodium terephthalamate and 1.1 per cent of sodium tallowate. This lubricant and one having only 10 per cent of the first thickener were subjected to bleeding tests run according to Standard Method 3454-T. The leakage of the product containing the mixture of thickeners was 8 grams, whereas the sample having only the terephthalamate lost 26 grams of oil.



Lubricating Grease Thickened with a Metal N-Substituted Carbamate

Martinek in U.S. Patent 2,957,-826, assigned to the Pure Oil Co., describes products in which lubricating fluids are thickened with 5 to 30 weight per cent of metal hydrocarbyl - substituted carbamates. Such lubricating greases are said to have high dropping points, low tendency to bleed and resistance to oxidation. While alkali or alkaline earth metals as well as aluminum, tin and lead can be employed in the thickener, the preferred metals seem to be lithium or sodium.

For example, a dispersion of 5.2 parts by weight of sodium metal in 15.6 parts of 200 viscosity neutral oil was prepared by heating the mixture in an atmosphere of nitrogen until the sodium had melted, followed by stirring at high speed until a fine dispersion was effected. The dispersion was then cooled below the melting point of sodium without stirring. To the dispersion of sodium in neutral oil were added 10.1 parts by weight of dimethylamine and 59.2 parts of the 200 neutral oil. Carbon dioxide was then bubbled into the mixture with stirring, until 9.9 parts by weight of carbon dioxide had reacted with the sodium dispersion and amine to produce a colloidal dispersion of 25.2 parts of sodium dimethyl carbamate in 74.8 parts of oil.

After cooling a light yellow, buttery lubricating grease resulted which had a worked penetration of about 200, was free from bleeding, had high shear and storage stability, and a dropping point in excess of 380°F.

Additives

Rust Inhibitors for Lubricating Greases

Dihydroxy-imidazolidone or derivatives thereof are suggested as rust inhibitors in lubricating greases by Badische Anilin- and Soda Fabrik Akt.-Ges. in British Patent 844,-433. While no illustrations of the use in plastic products is given, 0.1 g. of stearyl monoureine in 500 ml. of a proposed turbine oil of 3.5° Engler at 50°C provided protection against rust in ASTM Method D 665-52T when steel rods were held in the mixture at 60°C for 24 hours. The untreated oil permitted rust in one hour.

Application

Grease on Tap

At the 1960 Annual Convention of the Iron and Steel Engineers, Charles A. Bailey and Donald R. McCaa gave a paper on the above subject.

They state that lubricating grease handling in bulk is the result of improvements in the lubricants, methods of application and containers made available to steel mills. Now this industry is ready to make this product a utility item. Methods, practices and container designs, aimed at this end were presented to show how every steel mill can have grease on tap.

This paper will no doubt be published in the *Iron and Steel Engineer* and further reference will be made to it at that time.

Dependable Transportation

The September-October, 1960 issue of *Lubrication* (Texaco) is devoted to the above subject with special emphasis on the use of prop-

The C. W. Nofsinger Company

CONSULTING ENGINEERS

Grease Plants
Petroleum Refineries
Petrochemicals

"In Engineering It's the People That Count"

307 East 63rd Street
Kansas City 13, Missouri

The Literature and Patent Abstracts column is written for NLGI by C. J. Boner, chief research chemist for Battenfeld Grease and Oil of Kansas City, Missouri.

er fuels and lubricants for automobiles.

Of particular interest is the fact that Automatic Transmission Fluid Type A or Type A, Suffix A is considered a part of a very complex assemblage. Since the mechanism consists of: a hydraulic combination torque converter and fluid coupling; transmission oil pumps; one or more hydraulically-shifted planetary gear sets with their wet clutches, "brake" bands and servo mechanisms; an automatic control system or "brain" containing a speed-sensing or throttle modulator device; and finally, a series of intricate finely-finished automatic hydraulic valves which must be kept free from rust and varnish, it is quite evident why only approved lubricants be used.

Further, the publication stresses the importance of protection of this convenient assemblage by draining and replacing the Automatic Transmission Fluid at regular intervals of 10,000 to 26,000 miles or at least every year.

Steel Mill Lubrication

Scientific Lubrication (England) in the October, 1960 issue, p. 28, replies to certain questions regarding steel mill lubrication.

One question concerns the lubricating practice in British steel plants while rolling beams and channels and the reply is that it is practice to lubricate the thrust collars of heavy beams, piling, etc. but that this is not necessary when rolling channels, angles and other products rolled in diagonal passes where end thrusts tend to cancel each other out. When used, the lubricant consists of a stiff calcium-base lubricating grease with an unworked penetration of about 90 and a dropping point of 190 to 200°F. This grease is packed in canvas bags about 4 inches wide, 15 inches long and 2 inches thick. After sealing, the bags are hung so as to allow them to rub against the surface to be lubricated. The thought is that melted lubricating grease will seep through the canvas onto the thrust face of the collar. The average consumption of grease is stated to be about 1/8 ounce per ton of steel rolled.

Another question concerns lubricants which are suitable at temperature ranges of 300 to 700°F. The reply cautions that the temperature limits of lubricating greases are dependent upon the characteristics of the oil phase but that bituminous residuals are usable up to 550°F, lithium-base lubricating greases good up to 400°F when mechanically fed at short intervals, and Bentonite-base lubricating greases effective up to 440°F. Molybdenized lubricating grease is said to be used more as a first aid than as a regular lubricant.

Characteristics

Room Temperature Storage of Aircraft Lubricating Greases
John B. Christian, Materials Laboratory, Wright Air Development Division, Wright-Patterson AFB. April 1960. WADC Technical Report 58-287. Order from Dept. of Commerce OTS PB 161,808, price $.50.

Eleven lubricating greases qualified under Mil-G-3278, Mil-L-3545, Mil-L-4343, Mil-G-7421, and Mil-L-7711, and supplied by various manufacturers were placed in storage, at room temperature, for two years. The lubricants were examined periodically to determine if storage had affected any of their properties. At the termination of two years' storage, it was found that large changes in consistency had occurred in three out of five Mil-L-7711 lubricating greases. The penetrations of these samples were no longer within specification limits. All the other lubricating greases maintained the minimum requirements for their specifications.

Transfer grease 200 Pounds per minute!

●Designed for transfer, batching and packaging operations where grease is removed from drums, the Graco Bulldog Transfer Pump delivers up to 200 lbs. per minute of heavy grease and other semi-solid materials . . . *empties a 55-gal. drum in less than 3 minutes!*

High volume pump starts at TOP of drum, "sucks" way to bottom, cleans drum as it moves. Handles heavy greases in a fraction of the time needed by ordinary pumps. When drum is empty (right), pump can be quickly removed. *Ask for a demonstration!*

Free Idea Book shows Graco Pumps for every need. Send for it today!

GRACO
GRAY COMPANY, INC.
328 Graco Square • Minneapolis 13, Minnesota

(For Graco Suppliers, see SPRAYING or LUBRICATING DEVICES in Phone Book Yellow Pages)

News About NLGI cont'd

tion from the NLGI board of directors, effective January 31. First elected to the governing body in 1958, Ambler served a two-year term and was then re-elected to the board last November. He was a member of the chassis lubrication, membership, publicity and production survey committees.

NLGI's New Foil Seals Sell Well

Distribution of NLGI's foil seals of the little man with the industry message ("Give Your Car a Lift . . . Inspect Every 1,000 Miles . . . for Safety, Comfort & Savings") is going well, as member firms purchase these stickers at cost for their correspondence, advertising and sales promotion. The introduction was made last month.

Measuring an inch by an inch-and-a-half, each seal tells at a glance the car care story. The little registered character is in red, blue and black, overprinted on a bright aluminum stock, dressing up the appearance of whatever he appears on. He serves as an at-a-glance reminder of the necessity of visiting the service station and automobile dealer lube bay, for the inspection services given when the car is on the grease rack.

Also available to members is artwork for black-and-white (*above*), as well as three-color reproductions of the little man. Application is up to the NLGI company, but he was designed for a multitude of uses.

Work is continuing to develop a strong postage meter imprint design, which will enable companies to take advantage of this excellent medium. As yet unnamed, NLGI's little man is the object of a naming contest (*see below*) within the industry. Initial introduction of the character began ahead of these developments, in order that members could begin employment of this reminder to the motorist without delay.

Several grease manufacturers without service station outlets are offering stickers to their marketing customers. One company has indicated its intention of having its stationery imprinted with the design.

Foil seals are available through the national office, a box of one thousand for ten dollars, postage paid. Minimum order, one thousand. One and three-color artwork is offered to members without charge.

Contest on to Name NLGI's Little Registered Character

A number of names have been received at the national office, in NLGI's contest to give its little registered character a descriptive name. Introduction of the little man went ahead of naming, in order that he might be used immediately by the membership.

Contest rules: Any subscriber to the NLGI SPOKESMAN may submit up to five names . . . each entry will be noted as to date of postmark in the event of duplication, and names may be sent to NLGI up to Wednesday, May 10, 1961.

The winner will receive $50.

SIGN OF
CORRECT
LUBRICATION

Mobil

Makers and Marketers of
Mobil
Automotive
Products

Mobil
Industrial
Oils and Greases

150 E. 42nd STREET
NEW YORK 17, N. Y.

Make Your Reservation Now

Who:	The Lubricants Industry
What:	29th Annual Meeting, NLGI
Where:	Rice Hotel, Houston, Texas
Why:	To Learn the Latest Developments
When:	Sun.-Wed., Oct. 29-Nov. 1, 1961
How:	Write the Rice Today

Industry News

Petroleum Packaging Committee to Meet

Plans have been announced for the forthcoming two-day meeting of the Petroleum Packaging committee at the Sheraton Palace hotel in San Francisco, on March 13 and 14.

The PPC, formed in 1950, is a technical committee of the Packaging Institute and its work is endorsed by the American Petroleum Institute's lubrication committee and the National Lubricating Grease Institute.

The first day's schedule calls for a business meeting where some fifteen committees will report on subjects relative to the packaging, shipping, labeling, handling and storing of products produced by the petroleum industry.

Coordinating Research Council Elects McCoy

John T. McCoy, coordinator of Tidewater Oil company's eastern division manufacturing department, has been elected president of the Coordinating Research Council, Inc.

H. F. Barr, chief engineer of the Chevrolet Motor division of General Motors corporation, was elected vice-president of the CRC. E. C. Belefski, assistant treasurer of the American Petroleum Institute, was re-elected treasurer and Genevieve Walmsley was re-elected to the post of secretary. M. K. McLeod was re-appointed manager.

Coordinating Research Council is jointly sponsored by the American Petroleum Institute and the Society of Automotive Engineers, and conducts research investigations relating to fuels, lubricants and automotive equipment. Seven of the directors of CRC represent the petroleum industry and seven represent the automotive industry. Over 700 scientists and engineers serve on the many CRC committees, which work on both military and civilian projects.

McCoy was first elected to the CRC board in 1952 and has served continuously since that time. He has been a member of the executive committee of the board since 1957 and a vice-president since 1959.

New Organization for A-D-M's Chemical Group

A new customer-oriented organization for Archer-Daniels-Midland Co.'s chemical group has been announced by W. G. Andrews, executive vice president-chemical group.

The new plan establishes group marketing and production managers, five department managers and a field sales administrator. These replace the group's former three divisions—industrial chemicals, resins and plastics—each with its own pro-

If it rolls on an axle or turns in a
bearing or rides on a shaft if it slides
in a groove or moves on a pivot if
it bores or cuts or transmits pressure
one of Sinclair's 500 specialized lubricants
is designed to make it work better. For answers
to your lubrication problems, write today to
SINCLAIR REFINING COMPANY Sinclair
Technical Service Division, 600 Fifth Ave, N.Y. 20 N.Y.

duction and sales personnel.

Dr. George K. Nelson, formerly manager of the industrial chemicals division, was named marketing manager for the entire group and J. C. Burkholder, formerly resin division manager, was appointed group production manager.

The product departments and their managers, who will report to Nelson, are resins, W. C. Mueller, formerly sales manager of the resin division; plastics, H. B. Finch, formerly manager of the plastics division; industrial chemicals, J. H. Kane, formerly sales manager of the industrial chemicals division; plasticizers, W. A. Jarvey, and nitrogen chemicals, R. G. Freese. Jarvey and Freese formerly were product managers within the industrial chemicals division for plasticizers and nitrogens respectively.

The chemical group's field sales administrator will be Hall Dillon, who also will report to Nelson. Dillon was formerly sales coordinator for the resin division.

Andrews said the new organization was developed as a result of extensive interviews with ADM'S chemical group customers. It is designed to concentrate research, production, service and sales efforts on the specific needs and wants of these customers, he continued.

Kane has been with ADM since 1934, starting in the laboratory at the Wyandotte, Mich., chemical plant. He later transferred to sales and was assistant regional sales manager in New York in 1957, when he became sales manager for the industrial chemicals division. He is a native of New York and attended Detroit Institute of Technology and the University of Detroit. He serves as NLGI's Company representative.

McCarthy, Jr. Named to Young Presidents' Group

The 33-year-old president of Vulcan Containers Inc., Vern I. McCarthy, Jr., has been named to membership in the Young Presidents' Organization, a national group of more than 1600 business leaders who achieved presidency of their firms before their 40th birthday.

McCarthy, whose firm is located in Bellwood, Ill., a suburb of Chicago, becomes a member of the Chicago chapter of YPO, one of 34 chapters nationally. The Chicago chapter is one of the largest in the nation.

ASLE Announces Program For 1961 Annual Meeting

ASLE's 1961 annual meeting will have nineteen sessions, 70 papers and three panel discussions . . . whatever your interest in lubrication might be, the American Society of Lubrication Engineers will have something on the program for you.

The Bellevue-Stratford hotel in Philadelphia will be convention headquarters during the three-day session, April 11, 12 and 13, 1961.

Five separate sessions will be held on bearings and bearing lubrication, and attention will be given to seals and packings, properties of lubricants, lubrication fundamentals, engine lubrication, fluids for metal working, lubrication equipment, and machine tool lubrication. Special sessions will be held for the steel and railroad industries.

Joins New York Sales Staff of Werner G. Smith

Girard R. Adams has joined the New York sales staff of Werner G. Smith, Inc., 233 Broadway, 4902 Woolworth Bldg., New York 7, N. Y.

Adams received a B.S. in chemistry and biology from the University of Scranton, attended the Newark College of Engineering, and served in the Navy in World War II. He was previously employed by General Aniline & Film Corp., and Continental Chemical Co., in the New York-New Jersey area.

Werner G. Smith, Inc. is one of the largest producers of sperm oil products. Other fat-based chemicals include fatty acids, fatty alcohols, hydrogenated oils, core oils, fish oils, tall oil esters, methyl esters, self-emulsifiable products and hydrogenated waxes.

Adams will contact industries in the northern New Jersey, Metropolitan New York, and southern Connecticut areas.

LUBRICATING GREASES • METALWORKING LUBRICANTS • SPECIAL PROCESS OILS
BEMOL
BEMOLybdenum
Fortified Lubricants
mbi
ON GUARD SINCE 1888
Never Underestimate the Importance of Protective Lubrication
MAGIE BROS. OIL CO.
Franklin Park, Illinois • Chicago Phone TU 9-4800

Better Greases Through BAROID RESEARCH

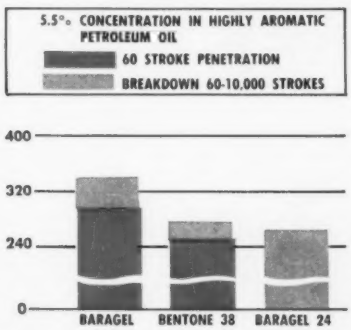
BARAGEL* 24 stabilizes greases made from petroleum oils

LABORATORY REPORT

BARAGEL* 24 in grease made from high aromatic oil

In a particular petroleum oil of high aromatic content (28%), BARAGEL 24 produced a grease completely stable to working in the ASTM grease worker over the range of unworked to 10,000 strokes.

In a series of tests, the oil used had an API gravity of 16.9° at 60° F and a viscosity of 309 SUS at 100° F. The worked penetration was 265 when

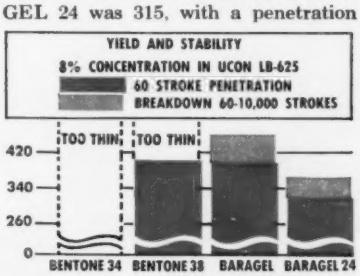


5.5% BARAGEL 24 was used. Comparisons of penetration when using the same percent of BENTONE* 34 and BARAGEL* are shown on the accompanying chart. Write to Baroid Chemicals, Inc. for Data Sheet A-4 which gives full details.

BARAGEL* 24 efficient thickener in greases made with Ucon LB-625

BARAGEL 24 is more efficient in thickening Ucon LB-625 than are BENTONE 34, BENTONE* 38 and BARAGEL. BARAGEL 24 greases are also more stable to working in the ASTM grease worker.

In a series of tests, the gelling agents were stirred into the Ucon LB-625, propylene carbonate was added, heat applied, and the mixture was milled. The chart below compares the results of thickening greases with BENTONE 34, BENTONE 38, BARAGEL and BARAGEL 24. The worked penetration of a grease made from Ucon LB-625 and 8% BARAGEL 24 was 315, with a penetration



of 355 after working 10,000 strokes. Full test details are available in Data Sheet A-1. Write Baroid Chemicals, Inc.

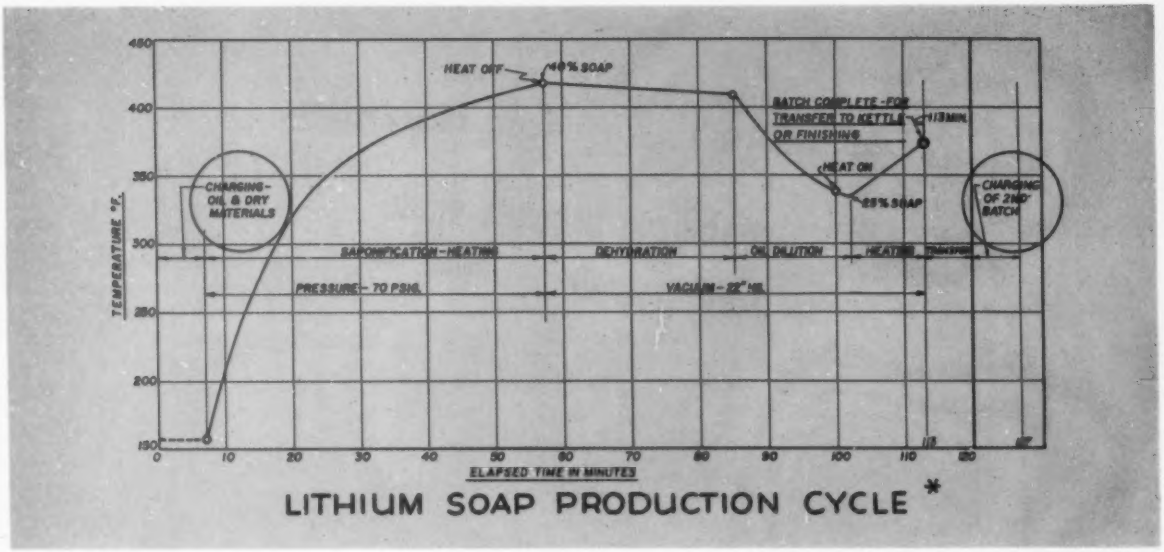
*Trademark of National Lead Company for an organic ammonium montmorillonite.

BAROID

BAROID CHEMICALS, INC.

A SUBSIDIARY OF NATIONAL LEAD COMPANY — 1809 SOUTH COAST BLDG. • HOUSTON 2, TEXAS

9111

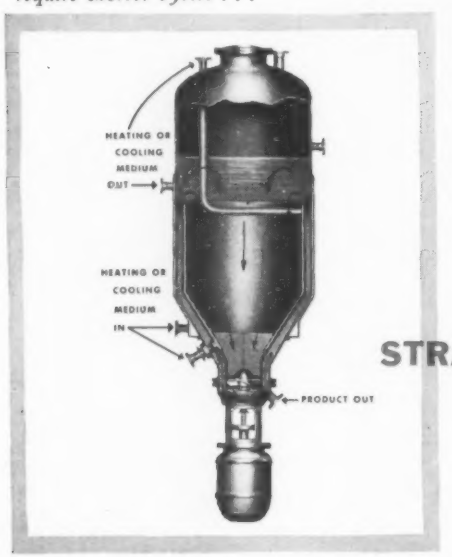


LITHIUM SOAP PRODUCTION CYCLE *

From base stocks to . . . finished soaps . . . in less than 2 hours

with STRATCO CONTACTOR

**Other types of soaps generally require shorter cycles . . .*



Stratco Grease Manufacturing has proved the most efficient method of producing today's great variety of greases because of:

- Complete and rapid saponification
- Extremely close temperature control
- High heat transfer rates
- Immediate and uniform dispersion
- High yield greases
- Reduced manpower requirements

STRATCO—the choice of economy and quality minded grease manufacturers for over 30 years.

REPRESENTATIVES

D. D. Foster Co., Pittsburgh, Pa.
D. D. Foster Co., S. Charleston, W. Va.
Lester Oberholtz, Los Angeles
Rawson-Houlihan Co., Inc., Houston
The Rawson Co., Inc., Baton Rouge
F. J. McConnell Co., New York

STRATFORD ENGINEERING CORPORATION

● PETROLEUM REFINING ENGINEERS

612 West 47th St. Kansas City 12, Mo.